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"The Principles of Athenian Architecture."

THE new edition of Mr. Penrose's great work on Athenian architecture,* perhaps the most notable illustrative work on architecture which this country has produced, though a re-issue, so far as the bulk of the volume is concerned, contains considerable and important additions, chiefly arising out of investigations made by the author and others since the publication of the first edition. It is also brought out in a wider-spaced and superior type to that of the first edition, rendering the volume more worthy, in form, of the important subject of which it treats. The majority of the plates are the old ones, but with some additions or corrections worked on them,—as in the general plan of the Acropolis, for instance, which has been altered so as to exhibit the results of more recent investigation, so far as Mr. Penrose accepts these; of which more anon. From the preface to the second edition, it appears that as long ago as 1883 the Society of Dilettanti (to whose liberality we are practically indebted for the existence of the work at all) determined to publish a new edition of the book; and it was mainly in furtherance of this intention that Mr. Penrose undertook to re-examine the buildings principally referred to, so that the discoveries of recent years might be incorporated in the book, especially in regard to the Erechtheion, which had been very slightly touched upon in the first edition; and he was desired to obtain permission, if possible, to make excavations for the purpose of obtaining the plan of the temple of Jupiter Olympius. His remarkable and speedy success in obtaining conclusive evidence in regard to this temple, and definitely settling the long-vexed question of its architectural ordinance, is known to our readers through our reports of his lecture on the subject at the Institute of Architects, in the "Transactions" of which a full report on the subject also appears. The account and illustration of this investigation, with wood-cut illustrations, forms a large and important addition to Chapter XII. of the new edition. In the plates, a new one is added as IX.A, containing some details as to the naos of the Parthenon not before published. In plates 27, 29, and 30 (plan and two sections of the Propylæa), some new details resulting from recent examination of the ground are added. Plate 34, showing some further details of the Propylæa, and the skeleton plan of the ancient temple discovered by Dr. Dörpfeld immediately to the south of the Erechtheion (and which Mr. Penrose calls the 'Cecropium"), takes the place of a former plate showing a restored plan of the ancient temple of Athene, destroyed by the Persians. Plate 40 is a new one, showing the plan of the Jupiter Olympius temple as excavated, and the indications for the restoration. Plates 41 to 45 are new, and give plans and sections of the remains of the Erectheion*; and Plate 46 corresponds to Plate 40 of the original edition. Of the new literary matter, besides the chapter on Jupiter Olympius already mentioned, Chapter I., "Description of the Acropolis," has an important second section on recent discoveries. To Chapter II., "The proportions of the Parthenon," is added a section on "more recent notes," referring to the Plate IX.A aforesaid. Chapter X., on the Propylæa, is very largely added to, with many wood-cuts. Chapter XIII. is an entirely new one on the Erechtheion. Chapter XIV., "On the remains of an earlier Parthenon," corresponds to Chapter XIII. of the original edition, but is nearly rewritten, and with a plan added showing the relative positions of the old and later "Hekatompeda." In the appendix Mr. Penrose prints nearly in full Mr. Watkiss Lloyd's in many respects remarkable paper on "The general theory of proportion in architectural design, and its exemplification in detail in the Parthenon," read at the Institute of Architects in 1859; an essay which Mr. Penrose apparently regards as the best exemplification of the idea as to regulated proportion, which was the basis of Greek architectural design, and the main conclusions in which appear entirely irrefutable. The rest of the matter forming the appendix stands much as before, with the addition of two short notes on "a recently-discovered fragment of the temple of Jupiter Olympius," and on some fragments of an inscription relative to the construction of the Erechtheion.

It is so long since the original publication of the book, and we have observed that many of the younger generation of architects know so little of its importance in connexion with the study of Greek architecture, that before touching on the points dealt with in the new chapters, it may be worth while to briefly recapitulate the scope and object of a work the authority of which has long been acknowledged by old students of Greek architecture.

The title, "The Principles of Athenian Architecture," is not, we may observe, a quite accurate indication of the contents of the book. Mr. Penrose's treatise is really a very acute and painstaking investigation of facts in the practice of the Greek architects, from which we may no doubt infer some of their "principles," but only in a piecemeal manner, and by putting various facts together; nor does the author in reality attempt to give any comprehensive summary or theory as to the principles of Athenian architecture. We make no complaint of this; he gives us facts, for the most part indisputable, which are worth a great deal more than theories; but the title of the book is apt to convey a mistaken impression to those who are unacquainted with it, and to lead them to think that it is only one of the many essays on "principles" which may or may not be true, instead of a repertory of most interesting and valuable facts. The main object with which Mr. Penrose commenced his researches originally was to ascertain, by minute and accurate measurements of the architectural monuments of Athens, the precise truth as to some very delicate curvatures and optical adjustments believed to have been employed by the Greeks, of which indications were given by Vitruvius; which had been in part guessed at by one or two modern observers; and the existence of which was first positively affirmed by the late Mr. John Pennethorne, who made himself certain by observation of the main fact, that lines commonly regarded as horizontal, in the Parthenon especially, and appearing so to the eye on casual inspection, were in reality curved, and curved with some distinct intention. What Mr. Pennethorne first perceived in a general way, Mr. Penrose set himself to investigate in detail, and his measurements and their record form a triumph of minute and accurate surveying work and draughtsmanship, even apart from the interest

* "An Investigation of the Principles of Athenian Architecture, or the results of a survey, conducted chiefly with reference to the optical refinements exhibited in the construction of the ancient buildings at Athens." By Francis Cranmer Penrose, Architect, M.A., F.R.A.S., &c. New and enlarged edition. Published by the Society of Dilettanti. Macmillan & Co., London and New York. 1888.

* We cannot but wish that Mr. Penrose had recognised the desirability of a uniform system of rendering the Greek names of the buildings. He retains "Erechtheum," "Theseum," &c. Then why not "Parthenum?"

of the facts which they revealed. In addition, however, to this investigation as to the curves of adjustment, and the system of proportioning the parts in Greek architecture, the book comprises the most careful and accurate delineation of the principal remains of Athenian architecture as they exist, in plan, elevation, and section; not a book of "restorations" or of architectural pictures, but of solid and substantial information for the serious student of architecture, and such as will remain a permanent record and illustration of the most remarkable and refined collection of architectural monuments of which we have any knowledge.

Of the facts absolutely and incontrovertibly established by Mr. Penrose as to the method of the Greek architects, the first is that of the slight curvature of some of the main lines of their temples for purposes of optical effect. It is extraordinary that it should have been left to an investigator of almost the present generation to establish this fact, since Vitruvius, who has been read by many generations of architects, asserts the practice in words far more plain and precise than he generally uses, indicating that if the line of the stylobate were laid level, it would appear hollow to the eye—"Alveolatus oculo videbitur," indicating plainly both the practice and the immediate reason for it, though into the further philosophy of the ocular deception which rendered such a correction necessary he does not attempt to go. It seems extraordinary, especially considering the reverence with which Classic architecture, and Vitruvius as its prophet, were regarded throughout the Renaissance, that no one until modern days should have attempted to test so remarkable a statement by reference to actual remains. The Great Italian Renaissance architects, however, had little access in most cases to Greek work, and the coarser execution of Roman buildings might not have shown these corrections, even had they been actually attempted. In regard to Roman work, indeed, it may be doubted whether Vitruvius describes actual practice so much as what he considered ought to be aimed at. That the curvatures of the Parthenon should have escaped the observation of those who were not looking out for them Mr. Penrose considers natural enough: they are so slight as to be barely detected by the eye, except by "boning," and probably the steps till a comparatively recent period were encumbered with *débris*, and no one had taken the trouble to ascend to the cornice. The architects and agents employed by Lord Elgin had opportunities of seeing these things, no doubt; but, as Mr. Penrose sardonically observes, "they were otherwise occupied." What was established on the publication of Mr. Penrose's original volume was the existence of a slight upward curve of the entablature and of the stylobate at the ends of the Parthenon, and a lesser proportional upward curve on the flanks: the entablature in each case being less curved than the stylobate. For the detailed measurements, the student must refer to the work; we may merely remark here that the largest curve of the kind discovered,—that of the front stylobate of the Parthenon, is equivalent to a rise of ·228 ft. in 100 ft. The existence of these curves is established beyond doubt; the eminent French architect, Le Sueur, persisted that they were due to settlement and opening of the joints; but micrometer measurements of the joints showed that such opening of them as there was, was the other way. The most careful attention was paid to this subsidiary evidence afforded by the condition of the joints, and by this attention Mr. Penrose was enabled to show that Mr. Pennethorne was mistaken in one of his observations, viz., in supposing that the front entablature of the Parthenon showed also a *horizontal* curve inwards from the two extremities. The joints here were found to be more or less open at the back, indicating that what curve there was had arisen from some displacement of the structure. It may be added that there is no conceivable theory as to optical illusion which could justify such a curve; a horizontal curve outwards would be more comprehensible.

It is not easy, however, on comparing the results of similar measurements on other Athenian buildings, to make out any definite and consistent system on which these curves were arranged, beyond this (which is a very intelligible principle), that the curvature of adjustment increases in ratio in proportion to the size of the structure; the small temple of Niké Apteros being without any such curvatures,—not even the entasis to the columns. But beyond this, it seems difficult to make out any general principle. The reason for upward curvature of the horizontal entablature beneath the pediment will be intelligible to any one who will draw out an obtuse-angled isosceles triangle, in straight lines, on a pretty large scale. The evidence of his sight will then show him the base-line appearing to "sag" by contrast with the raking sides of the triangle. The curvature of the stylobate will then follow obviously, as otherwise the stylobate line must appear hollow by comparison with the curved lines of the entablature. The curvature of the flank lines of both entablature and stylobate would then be necessitated, in order to harmonise with the lines of the front. But to carry out the theory completely it would seem that the raking cornice of the pediment should have a slight upward curvature, or it would appear hollow by contrast with the upward curve of the horizontal entablature. This, however, is not the case in the Parthenon. On the other hand, in the Propylæa the upward curve occurs in the entablature only, the steps being left level. Thus, although there can be no doubt that all these curves were the result of intention, and cannot be accounted for by settlement, as Le Sueur contended, it would seem that either the Greek builders themselves had no settled system, or that, whatever it was, we have not sufficient data for arriving at it.

The fact of the intentional entasis of the columns, first observed in the Parthenon by Cockerell, is questioned by no one now, though in the case of the Parthenon, Erechtheion, and Theseion, the curve is so slight that so careful an illustrator as Stuart represented the columns as absolutely straight-lined. The curve cannot, therefore, have been introduced from any preference for a curved line as a matter of beauty or expression in design, although it has been exaggerated into this in Roman and Renaissance examples. The theoretic reason for this entasis is more difficult to understand than the curvatures of the horizontal lines. Mr. Penrose gives some ingeniously-suggested reasons for it, for which we must refer the reader to his work. Our impression of the reason for it would be that the extent of the deviation of the outline of the column from the vertical line, caused by its upward diminution, would be exaggerated to the eye in the lower part of the column, by comparison with the line of the stylobate from which it starts; it would appear to recede more quickly there than in the middle portion of the column, where the eye sees it without reference to the juncture with the stylobate line, and accordingly it is made to recede more slowly from the vertical line in the lower portion. This view of the matter is at least in accordance with the evident object of many of the other corrections, such as the throwing outward of the line of the anta in evident relation to the falling away from it of the inner side of the tapering column, which, again, is leaned slightly inward towards the building with the same object. It would seem that the Greeks always had in view the fact that each main line of the structure acts and reacts upon the lines seen in connexion with it. Mr. Penrose's assertion that this entasis line of the column is a scientifically constructed hyperbola curve has been much criticised at various times as an over-refinement, and we have heard it strenuously called in question very recently by critics not without knowledge of the subject. One objection, of course, is that it is generally supposed that the conic section curves were not known to the Greeks at this period. No one, however, we venture to think, questions the accuracy and care of Mr. Penrose's measurements, and his figures, giving the theoretic hyperbola curve in comparison with the measured curvature on the column, at four different heights, seem conclusive:—

Height.	Offset of Hyperbola.	Offset to Column.
8·7*	·1392	·1397
15·75	·2875	·2886
23·0	·4613	·4618
31·43	·684	·684

It seems quite impossible that such a correspondence as this should be accidental. This is from the Parthenon column; and Mr. Penrose states that the coincidence between the theoretic and actual curve is quite as close in the case of the Erectheion column.

There is perhaps, however, more room for the scepticism which has been expressed in some quarters in regard to the curves of the echinus of the capital, and of some other mouldings. Mr. Penrose's first example is from the echinus of a well-preserved column in the peristyle of the Parthenon. He gives the upper portion (rather more than one-third of the whole curve) of the sectional line of the echinus as a hyperbola curve, the remainder as a portion of a circle of which the radius is 10 ft., the same radius as the portion of the hyperbola curve with which it "osculates." The curve produced is not so refined in effect as in some other cases. It seems difficult to believe that this rather illogical curve, if one may so speak, is the result of special design and mathematical setting out, especially as another example, from the pronaos, is shown as a pure hyperbola curve. Why vary the curve in this exceedingly minute manner in so small a detail? The facts certainly leave scope for the conclusion that the echinus may have been, after all, a purely architectural and not a mathematical design. Some other points seem to suggest that it is possible to exaggerate the belief in the extreme minuteness of care in every detail ascribed to the Athenian architects. For the slight and admitted variations in the width of abaci and metopes Mr. Penrose practically confesses his inability to find a recognisable motive. In one case (of a fallen capital) the abacus "is left ·02 wider than at first intended." The author "has no hesitation in assigning this capital to the column fifth from the north-east angle, near which it lies, where the intercolumniation on either side being for some reason or other unusually great, it was thought desirable to reduce, although by so delicate an *accommodation*, the difference between these and the contiguous intercolumniations, which otherwise in the architrave might have seemed too palpable." The intercolumniations from the third to the seventh column from the angle are given thus—

8·170: 8·249: 8·224: 8·189.

the column referred to (the fifth) coming between the second and third measurements quoted. What possible reason could be assigned for setting these two columns this slight space wider, except inaccuracy in setting-out? No doubt the abacus may have been accommodated to prevent the error becoming obvious; but, with all reverence to the Greeks, this seems rather like what in these days we call "fudging" the details; certainly, to give it as a proof of extreme delicacy of perception seems rather over-refining.

In regard to the Greek system of proportioning the sizes of various portions of a building,—the front to the flank, the height of column to height of entablature, &c.,—the essay by Mr. Watkiss Lloyd, well known to students of the subject, and which, as we have observed, is introduced as an appendix to Mr. Penrose's book, is nearly as unanswerable in the coincidence between the theoretic and the measured proportions as are most of Mr. Penrose's own figures. His conclusion, as many of our readers know, is that the Greeks employed for the most part ratios of proportion, in the Parthenon at all events, which, commencing at 1:6, "advance towards equality by ratios preserving the common difference between their terms of

* Measurements given in feet and decimals of feet.

5"; *e.g.*, 1 : 6, 2 : 7, 3 : 8, 4 : 9, and so on; the favourite ratios in the Parthenon being 4 : 9, 7 : 12, and 9 : 14. In the temple at Bassæ the ratios 1 : 3 and 2 : 5 are prominent, but are unknown in the Parthenon. Mr. Lloyd, indeed, shows sometimes that desire to find his theory everywhere which besets the theorist in general, as when he invites us to consider the employment of the ratio 2 : 3, as in accordance with his theory, since it may be expressed as 10 : 15. This will hardly do; but his comparisons between calculated and measured proportions are pretty conclusive. For instance, the ratio of the length of upper step of the Parthenon front to the full height of the front is taken by him as being, and intended to be, as 14 : 9. The length of the step is 101·341; the calculated height on this ratio should be 65·1478; the measured height is 65·185; and other measurements come equally near to the theoretic proportions. This, again, seems pretty conclusive that we are on the right track. The criticism of many modern architects may be, no doubt, summed up as "*cui bono?*" And might we not have an equally satisfactory building as much, at least, as six inches out of the scale? The answer would be that it might be equally satisfactory to us, but not to the Greeks. It seems hardly to admit of question that the Greeks had a sense of harmony about architectural proportion somewhat analogous to ours about musical proportion (though not reducible, probably, to an actual and unimpeachable physical basis like that of tonal proportions), and that our eyes do not see such things as their eyes saw them. Whether it is possible by training of the geometric sense to arrive at their position, and see things with their eyes, is a question; it may equally be a question whether it would be worth the effort. But it has to be recognised that to rightly understand the aim of the Greeks in architectural design we must bear in mind the important distinction between their view of architecture and ours. Mr. Penrose's work is the most valuable contribution by far that has been made towards enabling us to see Greek architecture from a Greek point of view: valuable especially in that it is, in spite of what we venture to think some little exaggeration here and there, for the most part so essentially practical in character; it gives us an array of facts laboriously mastered, the most remarkable *corpus* of information in regard to the evidence of the buildings themselves that has ever been got together; and, except in some minor details, the theories are deduced from the facts, and not built up apart from them as a mental recreation, as is palpably the case with much of Pennethorne's brilliant but fanciful folio on "The Geometry and Optics of Ancient Architecture."

We have left ourselves little space to touch on the portions of the book in which new matter is introduced, to some of which, however, we may return at a future time. The first of these additions is the new Section II. to Chapter I., on "More recent discoveries on the Acropolis." In these remarks, and the alterations to the plan of the Acropolis, Mr. Penrose is at variance with the German explorers in some points, and shows his characteristic caution and reserve in deductions. In the *Builder* for February 25 of this year we gave a small plan and description of the recent discoveries, as represented on Dr. Dörpfeld's theory.* The most important feature in the new discoveries is that of the platform, with remains of a temple, immediately south of the Erechtheion,—so close on the Erechtheion site, indeed, that the foundation of the north colonnade of the temple runs in a slightly oblique line under the south porch of the Erechtheion. Dr. Dörpfeld regards this as the ancient temple of Athene, references to which have been taken by many previous modern writers to signify the old Erechtheion. Mr. Penrose regards this building as the Cecropion, about the position of which there have been many questionings, Leake and other writers earlier in the century having regarded the Cecropion as being part of the Erechtheion: a position probably no longer tenable. Mr. Penrose makes no attempt to restore the interior plan of this temple; on his general plan of the Acropolis he merely gives the outline of the platform, but on a separate plate he gives a restoration of the plan of the peristyle. He restores it as an octastyle temple with sixteen columns on the flank. Dr. Dörpfeld, to whom is due the discovery of these remains, restores the temple with six columns in front and twelve on the flank. The English and German restorers have, however, worked from different data. Mr. Penrose accepts a fragment of a large Ionic capital, found near, as part of this building, and therefore restores it in such proportions as this fragment would indicate. He adopts the view of Leake, that the Ionic order was in the earlier period the national order in Attica,—a view, as he says, confirmed by the style of the Erechtheion, which immediately succeeded the building in question. Dr. Dörpfeld adopts the portions of Doric columns built into the north wall of the Acropolis enclosure as remains of this temple, and, of course, comes to a different result. Mr. Penrose attributes these Doric remains to the earlier Parthenon—an opinion which Leake had expressed before him. Our impression so far is that Dr. Dörpfeld is right topographically, and Mr. Penrose architecturally; that the temple was the ancient temple of Athene, but that Mr. Penrose's view as to the architectural restoration (as far as it goes) is the more probable. Mr. Penrose, in fact, coincides in thinking this "the ancient Temple of Minerva" (why Minerva?); but holds that it is also the Cecropion, or place of burial of Cecrops. The objection to this is that the Erechtheion inscription quoted by Mr. Penrose (p. 6) appears to us to refer to the Cecropion as in existence simultaneously, which this temple could not have been, as the Erechtheion goes over its site. He recognises this difficulty, as he adds: "Probably no temple bearing the name of Cecropium was standing at the time the inscription was written, but the name would have been preserved, and with, most likely, an altar erected on the old site." This seems a rather far-fetched explanation. In general, however, we cannot but admire Mr. Penrose's reasonableness and avoidance of dogmatism in regard to his views; an example which other explorers might well fellow. With the archæologists of the German school, it is too much the custom to announce each new theory as a discovered fact—a reproach which, in the case of Dr. Dörpfeld, is perhaps rather to be made against his friends than against himself; but, with all his brilliant powers of investigation and suggestion, he is somewhat too imaginative in temperament to be an altogether safe guide.*

The important additions to the chapter on the Propylæa refer partly to the result of Beulé's investigations about thirty-five years ago, and to other clearances in different parts of the site since, and a plan is given of the ground adjoining the entrance to the Propylæa as now existing. This important chapter, and the full illustrations of the Erechtheion, may well form the subject of some separate consideration on another occasion. One curious point touched on is the probability that the western wall, between the Caryatide porch and the large Ionic portico, had been taken down and rebuilt when the temple was converted into a church. This portion, with engaged half-columns outside and narrow pilasters within, was blown down in a storm in 1852. Dr. Dörpfeld called the author's attention to the fallen fragments of this work, and they both came to the conclusion, from the coarse style and execution of the mouldings, that the work was of another date from the true Erechtheion work, and had probably been filled in somewhere about the fourth century A.D., "before the Classical tradition had given way to Byzantine feeling." We regard this discovery (for if Dr. Dörpfeld and Mr. Penrose both coincide, we think it may reasonably be called a "discovery") with considerable interest, because we have always felt a dissatisfaction with all the restorations of that portion of the building, as meagre in appearance and not worthy of the rest of the structure. It would seem probable that the architectural world has been deceived for some time back as to this portion of the Erechtheion, and that it is not pure Greek work at all. Speaking of the building generally, Mr. Penrose remarks upon the minute symmetry which distinguishes each separate portion. Notwithstanding the unsymmetrical way in which the whole is composed, "not only are the intercolumniations spaced with the greatest exactness, but the joints of the stones forming the drums run exactly level;" and he adds in a foot-note, "this exactness of the joints shows that the marble was not concealed in any degree by painting." Not quite; it shows that there was nothing done that required the concealment of a decorative covering; but the Greeks might have made conscience of working the joints precisely uniform, even if they had intended to colour the work: we agree with the conclusion, but not with the argument. We may observe, however, that nothing can be more reasonable and truly architectural in spirit than Mr. Penrose's views on the probable method of applying colour in Greek architecture, and his restorations of some of the polychromatic decoration from traces found; a portion of the work which may be specially commended to the study of those who are not as yet acquainted with it.

In concluding for the present, we cannot help expressing a hope that it may be found practicable, in due time, to issue a cheaper edition of this representative modern work on Greek architecture, with a smaller page, and reduced illustrations, so as to bring the book, in all essentials, within the reach of a larger public.

* We should have made more clear at the time, which we observe we omitted to do, that this was a representation of the work mainly from Dr. Dörpfeld's point of view.

* We may add, however, that Dr. Dörpfeld's detailed restorations and criticisms are at least worth more attention than they seem to receive from English architects, if we may judge from the fact that no publication giving full information about them is to be found in the Library of the Institute of Architects. Mr. Penrose refers his readers to Dr. Dörpfeld's own writings and restorations in the *Mittheilungen* and the *Antike Denkmäler*, but no copy of any of the numbers of those publications is to be found in the Institute Library; a fact which seems to us to argue a culpable neglect or ignorance of what is going on in archæological research beyond this country, on the part of those whose duty it is to see that members of the Institute should be able to find in the library all the important publications of the day upon architecture. If not, what is the library for?

NOTES.

THE discussion which took place at the meeting of the Institute on Monday became a little tedious towards the end, and, as no definite resolution was passed, or even proposed, it is probable it may be condemned, in the minds of some people, as a waste of time, and its promoter may be looked upon by them as a captious and hypercritical person who finds pleasure in mere hair-splitting. But it is probable, as a matter of fact, that Mr. Ridge this time attained the only object he had in view, and that, in future, manifestoes on important questions, published in the name of the Institute, will be first submitted to a general meeting for approval, if not for discussion. Mr. Ridge's attack was mainly directed against the action of the Council in issuing, without consulting the general body of members, the two papers of advice that have lately appeared on the subject of the restoration of ancient buildings. He argued that such a proceeding was not only unconstitutional, but in the highest degree impolitic, inasmuch as the advice thus tendered lacked the weight which the assent of the general body of members would have given it, and, inasmuch as it was open to any member, under the circumstances, to repudiate the advice altogether. It very quickly became clear that the Council was conscious of having made an error, and the Chairman on its behalf did the only thing that was right under the circumstances by offering to consent to the papers being referred back to a committee for further revision. It certainly does seem

a little strange that, as the honorary secretary confessed, it did not occur to any member of the Council that a general meeting should be consulted on such a question. One of the chief uses of such a body as the Institute is to form, by discussi on, a professional opinion on such subjects, which shall have the weight attached to opinions that command the assent of the great mass of professional men, and if it had been found, as we have no doubt would have been the case, that much of the advice in question did not, unluckily, command general assent, then it would have been better to put before the public an expurgated edition of it, containing only such propositions as the majority of members approved, and which the minority would, therefore, have loyally assented to. One of the main facts relied on by the speakers for the Council and the Art Committee, as excusing their action, was that the papers were only a re-issue of a document originally printed and circulated in 1865 by the Council without consultation with the general body. This document was drawn up by a very representative committee, on which sat, among others, Mr. Beresford Hope (the then president), Sir Gilbert Scott, Raphael Brandon, Street, and Burges. In those days, we all know, the Council was practically the Institute, and, if it had not been so, the opinions of such men would at the time have sufficed to silence criticism. In any case, two blacks do not make a white, and the speakers who made the excuse, with the exception of Mr. Nevill, showed that they knew very well it was only an excuse. Mr. Nevill seemed only half conscious that professional opinion on the subject of restoration had made immense strides since 1865, and that the authority of Sir Gilbert Scott and the great restorers of his day is by no means accepted now without question. Mr. Ridge, in his remarks, showed himself to be far more in touch with the more enlightened ideas of to-day, and went so far as to make the suggestion that architects should cease altogether to speak of "restoration," and should frankly recognise that what they were called upon to do was to repair, add to, or rebuild, as the case might be. We think the suggestion singularly felicitous. The word "restoration" has been made the cover for so much vandalism and so many absurdities that it has very generally fallen into disrepute, and the very best thing that could happen to it is that it should disappear.

NOTICES have been given of the intention to promote a Bill in the next session of Parliament for the making of a railway through the western Highlands. The proposed route embraces some of the grandest of Scottish scenery. The line is to commence at Helensburgh, the present terminus of the North British Railway, twenty-three miles north-west of Glasgow. It will pass up the eastern shores of the Gare Loch and of Loch Long to the village of Tarbet on the west coast of Loch Lomond. Thence it will run along the western shore of the lake, by Ben Vorlich, pass through Glen Falloch, and cross the Oban Railway at Clianlarich. From the southern part of Glen Dochart it will turn to the north-west, through Tyndrum, and over Glen Orchy to Inveroran and Loch Tulla. It will then cross Rannoch Muir, and, passing to the south of Loch Ericht, run through the Valley of the Spean to the foot of Ben Nevis, its terminus being at Fort William. There will be two branch lines, one to Loch Lochy, on the Caledonian Canal; the other by Loch Eil to Arisaig, on the west coast. The length of the line will be about one hundred miles. Those who have travelled leisurely through these scenes of surpassing loveliness, will, perhaps, regret that they should be desecrated by the modern innovation which Mr. Ruskin so heartily abominates. But we live in a utilitarian age, and the fact that the construction of the proposed railway would develope the fishing industries of the Highlands should reconcile us to the inevitable.

AT a recent meeting of the Manchester Geological Society, the President, Mr. John Knowles, gave an interesting statistical account of the coal trade of Great Britain, extending over various terms of years. From it we select the following facts:—In 1859, 65,000,000 tons of coal were raised,—the latest returns give an output of 157,000,000 tons. The lowest rate of wages recorded in the Manchester district was in 1850, when the colliers received 4s. 3d. for getting a load of coal equal to 3 tons 10 cwt. During the Franco-German war 12s. was paid for the same amount of work. At the present period 7s. 10d. is the amount paid. In 1852, the average weekly earnings of boys and men in the same district was 16s. 3d. per week; in 1887 the returns gave 21s. 9d. per week. The total number of fatal accidents in collieries throughout the kingdom in 1857 was 1,119, when 65,376,706 tons of coal were raised, making one fatal accident per 58,422 tons raised. In 1887 there were 995 fatal accidents and 162,119,812 tons raised, or one fatal accident per 162,924 tons raised,—a most decided improvement. The best time for the coal trade,—namely, the period of the Franco-German war—was also the worst in another respect, because a large number of capitalists sank their thousands of pounds in the trade, raising rents and royalties all round. Let us hope tbat the present revival in the coal trade will not witness a repetition of the same folly.

WE have received a circular from the Franklin Institute of the State of Pennsylvania, U.S., asking us to assist in making it known that the Committee of the Institute is empowered to award certain medals for meritorious discoveries and inventions tending to the progress of the arts and manufactures. These are the Elliott Cresson Gold Medal, which was founded by the legacy of Elliott Cresson, of Philadelphia, and conveyed to trustees of the Franklin Institute, and is awarded "either for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship"; and the John Scott Legacy Premium and Medal, founded in 1816 by John Scott, a merchant of Edinburgh, who bequeathed to the City of Philadelphia a considerable sum of money, the interest of which should be devoted to rewarding men and women who make useful inventions. The premium is not to exceed twenty dollars, and the medal is to be of copper, and inscribed, "To the most deserving." The "Journal" of the Franklin Institute, which is issued periodically, is in itself sufficient indication of the advanced standard of scientific study maintained by the Institute, and of the value which should attach to its medals as indications of merit. Further particulars can be obtained from the Secretary of the Franklin Institute, Philadelphia.

THE Statistics Office at Berlin publishes the following curious data:—Of the machines now being driven by steam-power, four-fifths have been erected within the last twenty-five years. France possesses 49,590 stationary engines, 7,000 locomotives, and 1,850 ships' boilers. In Germany there are 59,000 fixed boilers, 10,000 in locomotives and 1,700 in ships; whilst Austria has but 12,000 fixed and 2,800 locomotive boilers. Neither England nor the United States are mentioned in the above list, which they probably far outstrip. The aggregate working steam-power in the principal steam-employing countries amounts in the United States to $7\frac{1}{2}$ millions h.p.; in England, 7; Germany, $4\frac{1}{2}$; France, 3; and Austria, $1\frac{1}{3}$ million. The locomotives of these countries number 105,000, representing another three millions of h.p., and the grand total for the whole world is 46 million h.p. As one h.p. equals the work of three horses, and as one horse equals seven men, it follows that the work done by steam throughout the world amounts to close upon a thousand million workmen, or treble the actual working population of the world. After making due allowance for "contingencies," it may, therefore, be said that steam has not only trebled human working power, but has enabled man to husband his physical strength, and thus to develop more effectually the intellectual faculties.

WE extract the following from the able and interesting Presidential Address of Mr. John Honeyman, as President of the Glasgow Archæological Society:—"It is matter of congratulation that our army of intelligent observers is yearly increasing, but there is all the more reason that we should be careful that their energies be not wasted, and hence one of the most pressing questions which can engage the attention of the archæologists of the present day is: How are the many independent workers to be brought into the mutual relationship most suitable for the accumulation of facts, and that profitable commerce which enriches both him who gives and him who takes? One thing is certain, that at no previous period have the same facilities existed for dealing with this question. In these days of cheap and rapid travelling, cheap postage, and especially of cheap yet absolutely reliable methods of producing and multiplying illustrations, we are in a position to take an entirely new departure in the matter of co-operation, by greatly extending the limits hitherto practicable, so as to embrace England and Ireland as well as Scotland, and even 'poor little Wales.' My own idea is that we want a British Association for this express purpose,—an Association of all the archæological societies in the country,—so as to organise the archæological work of the country as to turn it to the best possible account. The task ought properly to be undertaken by the Society of Antiquaries; but it is needless to expect that,—the more's the pity. Failing the Society of Antiquaries, the British Archæological Association might perhaps take it up as their exclusive function, apart from their annual congress, which would go very well along with it. The name of the association is the most appropriate which could be suggested, and the work to be done is great enough and difficult enough to satisfy the aspirations of the most indefatigable and ambitious executive, for it must embrace not merely the catching and bringing to a focus the scattered rays of archæological light, but necessarily, also, the rescuing from destruction or obscurity of the precious relics of the past,—the very instruments of our craft,—and the formation of a national museum of archæology worthy of the name."

THE effects upon the Glasgow Exhibition building of the storm which prevailed over Scotland generally on Friday, the 16th, and raged with extraordinary violence along the valley of the Clyde, furnished a significant and, perhaps, not inopportune commentary on a proposal recently made to retain a portion of the building as a permanent public institution. Although the removal of exhibits and certain displenishing operations had been diligently in progress since the final closing, the building itself, when the storm of last week burst forth, stood intact, in pretty much all the structural stability it ever possessed. A large force of workmen and others was engaged in the removal work still remaining to be overtaken, without noticing greatly the howling of the tempest, and certainly without dreading damage to the huge structure that covered them, when suddenly the apex or ridge of the roof of the Grand Hall was, along the whole of its length, wrenched away from its fastenings and hurled down upon the roof of the courts devoted to the women's industries, situated to the north of the Grand Hall, and of considerably lower elevation. At the same time the fury of the wind made its mark upon the central dome, in the immediate neighbourhood of which, namely, on the main transept leading thence to the southern entrance (a part of the building it had been in contemplation to retain) a hole of large size was pierced, whereby the stalls beneath were at once exposed to the downpour of rain and hail then going on. Minor damage was inflicted at other points, and the authorities lost no time in clearing the Exhibition of all operators and shutting it up to await a cessation of the

storm. Some ladies at work in the Women's Industries section had a narrow escape, and, as it was, one person there engaged sustained severe wounds over the face and neck from falling metal and glass. Miscellaneous casualties in Glasgow and neighbourhood were numberless.

WE read that a scheme has been set on foot for constructing some deep-water docks at Mostyn, on the river Dee. Having inspected a site by Mostyn Quay, Mr. H. Whalley, of Chester, surveyor, makes a favourable report, and advises that the existing boundary walls can be utilised, at a considerable saving of expense. The coal-fields here are among the most extensive in Flint-shire. The London and North-Western Railway main line between Chester and Holyhead passes close by the spot, and, it is said, the company have agreed to advantageous terms for the projected traffic. Concurrently with this venture we learn that a private Bill will be promoted in Parliament next session to amalgamate under one sole direction the various Welsh railways, which, upon the completion in the course of, as is hoped, eight months hence, of the bridge across the Dee, will be placed in through communication with the lines that run through Lancashire and Yorkshire.

THE Earl of Shrewsbury and Talbot—a name once so dreaded in France—strikes out a leading idea in his project for a "Compagnie Générale des Hansom Cabs à Paris." An attempt in that direction was made some thirty-three years ago, but whilst Paris (with one or two continental cities) can boast of her *coupés*, the various companies still rely upon *fiacres* for their common plant. The new Parisian hansoms will be of the "S.T." (surmounted by a coronet) pattern now plying in London, as built by Messrs. Forder Bros. & Co., fitted with steel and rubber tyres, and will be drawn by English horses. At first the experiment is to be made with 300 vehicles only, a number that will probably be increased on the opening of the Exhibition next year. We may expect soon to see a "cocher de groulaire-Talbot" figuring on the boards of the Palais Royal. If the enterprise proves to be a success the company intend to carry their operations into the larger provincial towns of the Republic.

THE collection of drawings by Cotman at the Burlington Fine Arts Club is of great interest, and contains some very fine examples of his peculiar genius; but it is not as complete as we had hoped to find it, and the collection made at one of the art exhibitions, held "in the seventies," in the galleries since devoted to the "Fisheries" and the line of succeeding exhibitions, included, if we remember right, some exceptionally fine works which are missing here, especially sea-pieces. It is unfortunate that the Burlington collection has not more of this class of work, for it was in his sea views of the Norfolk coast, with its low land-line and great expanse of sky, that Cotman's special powers, perhaps, showed to best advantage. His remarkable power of giving the effect of a wind-swept sky had full scope here, and in painting the sea he was always at home. The best of his sea-"bits" rather than sea-pieces (they are all small examples) in the Burlington Club, is No. 37, "Boats off Yarmouth," in which the swing and movement of the waves in the foreground is splendidly given; nearly as good is 41, "On the Dutch Coast." A wonderfully rich and glowing work, "The Hay-barge," which was in the Kensington collection, we do not find here; there is a small drawing of a similar subject (58). The finest thing in the room is, perhaps, the one which has been rightly hung in the centre at the top, the "Mont St. Michel" (77); there are two or three of the same subject; the grand feature of this one is the immense mass of white cloud which forms a background to the mount and the castle; the whole thing is in the spirit of Turner at his best. Many of Cotman's architectural drawings are of great interest, and show, as Mr. Wedmore says in the preface, a great knowledge of architecture, but his architecture (especially in interiors) is often deficient in texture and force, — too "washy." The remarkable interior of "Crosby Hall" (78), is an exception. Among landscapes, besides those already mentioned, is a very fine little broad sketch, called "Down Scenery" (65); a scene in the gorge at Clifton, now spanned by the Suspension-bridge (76), taken at the time the rock was being blasted in preparation for it; "Byland Abbey (2), a fine sketch; "Norwich Market-place" (13), a large and elaborate drawing with many figures, architecture well rendered, and a beautiful bit of breezy-looking sky; "Draining Mill, Lincolnshire" (25); "Ely Cathedral" (22), a view from the park on the south-east, very rich in the effect of the masses of trees with dashes of sunlight over them; "Woodland Stream" (45), a fine sketch of a romantic landscape, showing a very bold use of colour. All who care for landscape art of a high quality, expressed in a pure water-colour medium, should visit the collection, to which access is generally readily gained through the kindness of members.

A MONUMENT has been erected in the Schloss-platz at Stuttgart, to Dannecker, the sculptor of the well-known "Ariadne and Panther" at Frankfort.

OF the five etchings by Mr. R. W. Macbeth, after works by Velasquez and Titian, which are on view at Mr. Dunthorne's Rooms in Vigo-street, the finest and most completely successful is that after the portrait of Alonso Cano, in which the reserved and simple grandeur of the original work is fully preserved. Mr. Macbeth has, however, produced a fine reproduction of the much more elaborate work, "The Surrender of Bréda," which is not so suited to the special capabilities of etching as the portrait. The two works by Titian which are represented are the "St. Margaret" (so-called), not a work of the highest interest, and the "Garden of Love," filled with cupid figures under a mass of trees, and with gleams of light in the sky beyond. This is a very fine etching, and it may especially be noticed how very well Mr. Macbeth has succeeded in conveying an idea of the tone and character of Titian's sky,—a kind of sky which is Titian's own property, and at once recognisable even in this translation.

A RECENT but short-lived novelty in Regent-street has been the sign of the "Arts and Crafts Exhibition Society," which for a day or two hung from a splendid pole over the rather obscure entrance to the "New Gallery." It would be recognised at once as the work of the President, Mr. Walter Crane. A winged figure upon one side, the Society's evangel, heralds the union of Art and Craft. On the other, the Artist and Craftsman (the two being so slightly distinguished as to avoid all possibility of offence to the latter) strike hands upon a vow of friendship. Unfortunately, owing to causes with which we are not concerned, this effective sign was removed after a very brief appearance in public.

THE SEWAGE QUESTION IN BIRMINGHAM.

THE following account of a visit recently paid by Mr. Charles Hancock, F.S.S., to the Sewage Farm at Saltley and the Interception Works in Montague-street,—where the "pail" contents are treated,—will be read with interest:—

"Tuesday, the 6th inst., was the date of my visit to the works in question; and I may preface the matter by giving a few figures kindly handed to me by the borough engineer, Mr. W. S. Till, C.E.

The total area of the Saltley Sewage Farm is 1,227 acres, of which 888 are freehold, the remainder being leasehold. The total area of the drainage district (which includes Birmingham, Aston, Handsworth, Saltley, Harborne, Balsall Heath, King's Norton, and Smethwick) is 47,275 acres, with a population (in 1885) of 619,693, and with a rateable value of 2,401,093*l.*

The *actual* cost of the outfall works,—*i.e.*, of the land, tanks, and works for the purification of the sewage,—amounts, for the year 1887, to 34,995*l.*; while the *actual* income, for the same year, reaches a figure of 20,346*l.*, the costs of management, as I understand, forming a separate charge.

I now proceed to describe shortly what I saw, and the results of the various inquiries I made. On arriving at Saltley, I was met by the sub-manager (Mr. Rumble), who gave me the following information:—

During dry weather, the amount of sewage that passes through the sewers on to the farm is 16,000,000 gallons per day. The sewers running on to the farm are three in number, the largest of which is 6 ft. 6 in. high and 9 ft. wide.

For purposes of precipitation, &c., about eleven tons of lime are used daily, that is, every twenty-four hours, machinery being kept in motion day and night.

The lime is first 'slaked' or cooled, remains in bulk for twenty-four hours, is then conveyed into an upper storey of the lime-shed, where it is emptied into a large vessel resembling a brewer's mash-tun. Here it is joined by a portion of sewage pumped from the sewers,—a portion which is emptied into this receiver at the other side. By means of two large revolving stones inside the receiver, the lime is ground to a powder, and the compound of sewage and lime, which by this time is converted into a 'milk of lime,' is run into the 'roughing' tanks, where the grosser impurities are precipitated.

There are three large tanks and sixteen smaller ones, the latter of which, however, are only used under certain circumstances, but which are a valuable auxiliary at times of heavy floods, when the normal quantity of sewage is largely increased. The total capacity of the tanks is 1,169,360 cube feet. From the tanks the sludge is elevated into wooden carriers, which can be moved so as to allow the sludge to flow into any of the beds formed to receive it on that part of the farm. The sludge so elevated is raised by an endless chain of bucket-dredges, the motive-power being supplied by two horizontal steam-engines, in duplicate, with link-reversing motion, by Tangye Brothers (of 20 h.-p. each). Both are kept in a perfect state of cleanliness—a circumstance upon which the engineer seemed especially to pride himself. It is only necessary to keep one engine going at a time, the other being kept in reserve in case of breakdown. The cost of the elevation is about 10s. per day (including fuel and labour). This part of the farm is superintended by the sub-manager (Mr. Rumble), who informed me he had worked there for nearly fourteen years. Speaking of the tanks, he said two of them were constantly being emptied, while the other one could be cleaned.

Noticing a large deposit at the bottom of one, the question was put by me:—

What is that particular deposit?—This is a deposit which always stops at the bottom, sometimes in very small quantities, and at other times larger ones.

What do you call it, is it detritus?—Yes, and we sell it to the farmers, who are very pleased to buy it.

How long is the sludge allowed to stand on the land before it is touched?—About fourteen days. When it is deposited on the land, it contains a great deal of water, which is allowed to drain away or evaporate. This done, a thick layer, about 10 in. or 1 ft. thick, remains, which is then 'trenched into' the land by spade labour.

Then what follows?—Various crops are planted on the land.

At what intervals do these dressings take place?—Every four years.

I see you have a large conduit here; where does that go to?—To Tyburn. The conduit is 8 ft. wide, and passes the sewage under the river by a syphon arrangement.

Would the sewage that goes to Tyburn be, or answer to the name of, 'precipitated sewage?'—Yes.

Is it not a fact that the sewage matter here is not very strong?—Yes; that is so.

Owing to the small amount of manure ingredient which passes into it?—Yes; it would be better if more manure passed into it.

Do you get any powdered granite in the sewage?—Yes; that comes from the granite paving in the streets. It is passed on to the land with the sewage.

Do you find the land any worse at the end of, say, two or three years?—No. This piece of land (pointing to a large plot upon which some fine cabbages were growing) has been done for the fifth

time, and it is no worse now than it was before. It is quite as good.

Do you grow anything on this part of the farm from the raw sewage?—Yes, we grow cabbages.

Supposing any one said they could taste the sewage in eating any of the vegetables that are grown here; would that be true?—I should say not. I have never heard of such a thing. It would be pure imagination.

You have grown some very fine vegetables here, have you not?—Yes, we have had a cabbage weigh as much as 80 lbs.; while we have a field in which some are often grown at 40 lbs.

How is the precipitated sewage brought on to Tyburn from the conduit?—After passing along the 8 ft. conduit to Tyburn, it is pumped to the higher land there at a cost of about 100*l.* per year.

And do you say that the tanks are emptied by the bucket-dredgers?—The whole contents of the tanks are taken out by the buckets; they want very little cleaning out afterwards. Tyburn is about two miles further on, and here it is that the manager of the farm (Mr. Tough) lives.

I then put the following questions to Mr. Tough:—

Would not the extension of the water-closet system be all the more beneficial to the farm?—Yes, a great deal; because much of the manure which is now taken away in pans (or pails) would be brought on to the farm. This manure in the pans, under the existing system, is sold to the farmers and others.

Do you find the absorption good?—Very good indeed.

I see that Dr. Lawson Tait has been recently interviewed with reference to this farm, and he said, 'The land is being covered by powdered granite and other useless débris at the rate of about an eighth of an inch every year; so that long before the last instalments of the money borrowed for it have been paid it will be choked.' Do you agree with that opinion?—I do not agree with it at all. No land can become clogged if it is properly ploughed; but if you do not plough your land it is sure to become clogged. An ordinary farm that has deposits of manure put upon it, and is not ploughed, will become clogged in time. The land would certainly not be clogged before the last instalments were paid.

Have you land enough?—Yes; but we shall require more as the population increases.

Has irrigation always been in use?—No; ten years ago they used nothing but the tanks.

There is a great deal of iron in your sewage. I notice that a certain Dr. Clay some years ago said: 'Iron ought to be positively excluded from the Birmingham sewage, as it has a great affinity for some of the acids, and would, if not neutralised, be highly poisonous to vegetation were the sewage containing it to any extent applied to growing crops, as, once deposited in the soil, it is only removed by them in small proportions; and it is possible to conceive that by constant deposits of sewage matter containing iron the soil would be unfit for the higher classes of vegetation.' Do you find that so?—No. The lime we use will neutralise and kill all the iron in the sewage. The quantity of lime used by us—that is eleven tons a day—is quite enough to kill anything that comes into the sewage. The lime is both for this purpose and for precipitation. If you look at these cabbages you will see that well enough.

Do you use much raw sewage?—Very little.

Is the whole of the sewage absorbed by the land. Does it go through the pores of the land?—It is not absorbed. It goes through the land into the drains.

I suppose you mean in the form of effluent?—Yes.

How do your cattle thrive on the land?—Very well. They never have anything the matter with them, except a cold or something of that sort. They have nothing ever ailing them that arises from the land. A large dairy stock is kept on the farm, and the yield of milk is very good.

Do you have any complaints of nuisances arising from irrigation?—None whatever.

How many are employed on the farm?—Altogether—that is, men and boys,—about two hundred.

Does the irrigation affect their health?—Not at all; they are all remarkably healthy.

What crops do you grow?—Potatoes, mangolds, parsnips, carrots, kohlrabi, cabbages, rhubarb, and Italian rye-grass.

Do you find a good sale for the rye-grass?—Yes, we get 15s. per ton for it, and the buyers come and fetch it themselves.

How much land have you upon which your rye-grass is grown?—About seventy-six acres.

And how many acres have you under irrigation at a time?—From 100 to 150 per day.

What land do you irrigate during the winter?—All the fallow land.

Are any of the potatoes grown on the land affected with disease at all?—No; they are remarkably free from disease.

Do you have to purchase any manure?—None at all. We use the manure from our own stables, but have no other. Neither do we use any artificial.

What becomes of the storm-water?—It goes into the river.

But in time of floods does not the whole system become more or less disarranged?—Only for the time being,—that is, for a few hours, during which time we get more than the normal quantity of sewage.

Take July in this year for instance; did that affect the land?—Oh! not at all. This year's rain has not affected us.

Is the whole farm under-drained?—Not all of it, but it will be in another twelve months.

Have any improvements been made during the time you have been here?—Well, yes, the drains were formerly a chain apart, now they are being put half a chain, and when that is done the whole of the land will be properly drained.

What about the effluent water?—That runs into a culvert and thence into the river. The culvert is two and a half miles long. If you will come here, you will see the whole thing. After being emptied out of the pans, excreta is dried and thence converted into 'poudrette.'

Mr. Tough then led the way to the edge of the farm until the culvert was reached. The water which was running down it was perfectly clear and odourless, while a stream under the spot where he stood sparkled with remarkable purity. Stooping down, Mr. Tough brought up some in the scope of his hand, and upon applying one's nose to it, no trace of stench or smell of any kind could be discerned. Mr. Tough seemed genuinely enthusiastic at this point, and said, 'At the other side of the farm you saw the raw sewage come in: here you see it go out as effluent.' Questioned as to the depth of the under-draining, Mr. Tough said he had one at a depth of 4 ft. 6 in., and that would probably be the average depth.

Interception Department, where the 'pail' contents are treated.

This is in Montague-street, in the midst of a very populous district, about half a mile from the centre of the town. The department covers nearly 14 acres, and gives employment to about 300 men. The manager is a Mr. Wilkinson, but he being absent, the chief engineer (Mr. A. Lyall) explained the process.

Do you get ammonia in the excreta?—Yes; there is a good deal of ammonia in it. This is 'fixed' with sulphuric acid, then dried, and so made into poudrette.

Do the people in the neighbourhood complain of the smells?—Not at all. There is but little smell, and any one working here, or living close by, would not notice it.

Do you get a ready sale for the poudrette?—Yes, a very ready sale. Last year we could not supply it fast enough.

What price do you get for it?—It averages 6*l.* per ton, although we have got as much as 6*l.* 10s., and many of the buyers fetch it away with their own carts.

Do they get much ammonia in the manure at the farm?—No, they do not. We get 7½ per cent. of ammonia in ours.

What system do you call this?—This is the Rochdale system,—that is, the mixing of fine ashes with the excreta. It is taken, as all the 'pail' systems are, from Rochdale.

Have you introduced any improvements at these works?—Yes; we have introduced hot air into the cisterns instead of cold air.

Do any farmers buy the excreta before it comes to you?—Yes; several of them.

How often are the pans emptied?—Once a week. The men are sent out in charge of the waggons, and are supplied with a list of houses to which they are to go. The privies are always open to them, and they take out the full pan and in its place put the empty one. The ashes and other refuse are in a tub which they empty on to the end of the waggon, while the pans are put inside.'

On the 7th inst. I was favoured with an interview at the Council House with Mr. Alderman Avery, J.P., the Chairman of the Birmingham Tame and Rea District Drainage Board. He admitted that the precipitation process 'by itself did a great deal, but it was uncertain in its operation.' It had, further, this virtue about it,—it gave the land so much less to do. He also insisted on the fact that one acre of land was as efficient for all purposes as eight or ten acres would be, unaccompanied by the preliminary precipitation treatment as in operation at the Saltley Farm. As to the proposals at various times put forward for irrigating the London sewage on the intermittent filtration plan or otherwise, he wished to remark that in his (Alderman Avery's) judgment the irrigation system was even more applicable there than in Birmingham, and for this reason: with them the volume of the river Tame was below the flow of sewage, but in London that of the Thames was 400 times above the sewage-flow.

Reverting to Birmingham, he said the Corporation had had sixteen years' experience of a sewage farm, but had worked the wider area only eight years. In a word, they had tried this system all these years, and, on the whole, were abundantly satisfied with the results obtained.

I also called upon Dr. Lawson Tait, late chairman of the Health Committee of the Corporation, from whom I heard a somewhat different story; but he acknowledged that the death-rate of Birmingham, in his time, had fallen to 19 per thousand of the population; and this he attributed to the admirable sanitation carried out of recent years by the town authorities.

Since writing out these notes, I have this morning (9th inst.) received the following letter from Mr. Till, C.E., the Borough Engineer:—

"Council House Engineer's Office,
Birmingham, Nov. 8, 1888.

Chas. Hancock, Esq.,
London.

DEAR SIR,—As promised yesterday, I forward herewith printed copy of estimates of income and expenditure of the Drainage Board for the current year, with which you will find statements of the income and expenditure for 1887.

The Books of the Health Department of the Corporation have not been kept so as to show separately the cost of dealing with the pail contents and old ashpit refuse since 1883. On the other side I send you statement of income and expenditure in respect of this work for that year.—Yours, faithfully, (Signed WILLIAM TILL.

Copy Inclosure (above referred to).

INCOME AND EXPENDITURE
OF THE
HEALTH DEPARTMENT OF THE CORPORATION OF BIRMINGHAM
FOR THE YEAR 1883.

Old Department (Privies and Ashpits).

Income, 1,928*l.* 7s. 11d. Expenditure, 11,609*l.* 17s.

New Department (Pails and Tubs).

Income, 9,690*l.* 12s. 10d. Expenditure, 33,024*l.* 10s. 4d."

THEORY OF ARCHED STRUCTURES.*

IN dealing with the theory of arched structures, the author has endeavoured to put the subject before the Architectural Association in as practical and simple a manner as possible.

We may theoretically divide arches into two classes: (1) treating of arches constructed of blocks of stone or brickwork, termed "voussoir arches"; and (2) treating of structures which are continuous partly or throughout, and which are termed, for distinction, "elastic arches."

In a short paper it would be impossible for the author to endeavour to exhaust the whole subject of arch construction. He has, therefore, confined his remarks to those arches which are made up of cemented blocks, as the elastic arch belongs more to the province of civil engineering, whereas the voussoir arch plays an important part in nearly all structures designed by an architect. The laws which govern the stability of arches are the same for arches of any shape or form, whether applied to a bridge, vault, dome, or to any other arched structure. With this assumption it will be immaterial what form of arch the author illustrates to enable him to elucidate the theory, as any other form of arch can be treated in a similar manner. As a basis, it is usual to assume that each bed-joint in an arch-ring acts as a hinge about which the voussoirs are free to turn, and no allowance is therefore made for the adhesion of the mortar in the joints, so that to obtain stability the arch should be in equilibrium throughout.

There are many reasons why the adhesion of the mortar should not be considered: first, that in some cases mortar between the voussoirs has been left out altogether, and sheet lead substituted; secondly, that the mortar or cement, although generally good, may, through carelessness, be inferior in some of the bed-joints; thirdly, that an accumulation of dust, and neglect to saturate the surface of the material with water, may effectually prevent proper adhesion; and fourthly, vibration of the centres may be produced by the deposit of material, or movement may be caused by the varied positions of the loads as the work advances up the haunches.

In arches there are three different causes of failure, which the author has dealt with in the following order:—

(1) The arch may not be in equilibrium, and may collapse by altering its form.

(2) The stones may be crushed.

(3) The voussoirs may slide on their bed-joints.

* By Mr. Arthur Thomas Walmisley, M.Inst.C.E. being a paper read before the Architectural Association on the 16th inst., as elsewhere mentioned.

The curve of equilibrium being an imaginary line representing the centre of pressure throughout the arch (supposing that the material were strong enough to resist crushing), the whole of the arch-ring might be removed except that portion immediately around the curve, and the arch would still remain perfectly stable.

To render this thoroughly intelligible, let us imagine a cord suspended between two points (fig. 1), and weighted with equal weights at

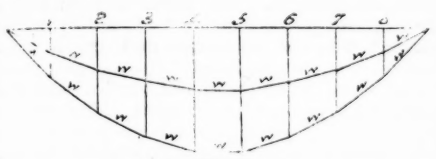


Fig. 1.

points 1, 2, 3, &c., then the position of repose of the cord will be the curve of equilibrium for the loads acting on it, and if the parts of the cord W, W, W were bars simply jointed at the weights, it could be inverted, as in fig. 2, and

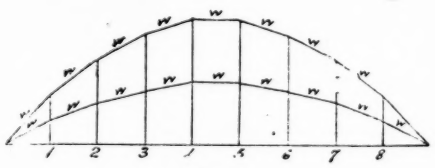


Fig. 2.

thus form a polygon in equilibrium, with the line of pressure along the centres of the bars. In the diagram two curves are shown for the same loading, and this line of pressure would be the curve of equilibrium for an arch loaded in the same way as the cord, and would also assume exactly the same curve as the suspended cord.

The curve of equilibrium changes its form for every alteration of load, except when all the weights are altered in the same ratio, in which case the load can be augmented or diminished, and the same curve maintained.

One of the conditions usually adopted with regard to the curve of equilibrium is that it should everywhere be within the middle third of the arch-ring—that is to say, if we divide the depth of the arch (fig. 3) into three equal parts,

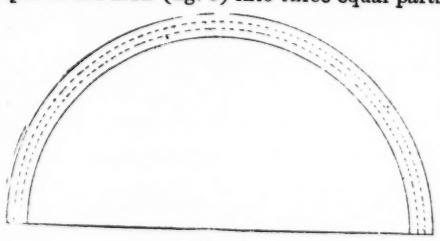


Fig. 3.

forming concentric rings, the curve should everywhere be contained in the middle ring.

This appears at first sight to be rather an arbitrary condition, but can be easily explained.

It is a well-known fact that all bodies are elastic, so that they will be extended or compressed according to the nature of the stress put upon them, and as we cannot have a tensile stress in masonry or brickwork without taking the mortar or cement into account, we must so distribute our pressures that no tensile stress will be set up. It therefore becomes a question how far the line of pressure may deviate from the neutral axis of the arch without a tensile stress being produced.

No doubt it has frequently been observed that if a plank of wood floating on water is loaded at one end, the loaded end will sink below the surface, while the unloaded end will rise above the surface until equilibrium is obtained, or, in other words, until the centre of bouyancy of the plank is coincident with what we may term the centre of effort of the water. The rise and fall of the ends of the plank relative to the water surface depend upon the position or amount of the weight placed upon it, and it will be found that the bottom of the plank at the higher end will just be level with the surface when the centre of gravity of the united weight of the plank and imposed load is one-sixth of the length of the plank from its centre.

This same law can be applied to masonry, for, the stones being elastic, the compression of its particles will be in proportion to the weight supported; and when the centre of pressure is removed one-sixth of the length of the bed-joint from the centre, the edge of the stone furthest from the load will be relieved from pressure and become just on the verge of tension, which is a parallel case with the bottom surface of the plank at the furthest end being just level with the water.

When the curve of equilibrium or curve of pressure is anywhere within one-sixth of the length of the bed-joint from the neutral axis of the arch upon either side, it will be in the middle third, and no tension will be produced. As the curve of equilibrium approaches the edges of the arch-ring, tension will be produced, which will gradually increase until the curve passes outside the arch-ring, causing it to collapse, but practically the arch would collapse much sooner from the crushing of the material.

Where the curve rises above the extrados of the voussoirs the arch would sink, and where the curve passes below the soffit the arch would rise, as shown in fig. 4.

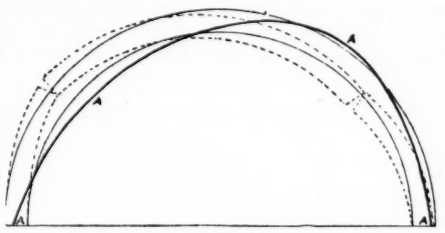


Fig. 4.

An infinite number of curves of equilibrium can be drawn for the same loading, depending upon the rise given to the curve.

The selection of the true curve generally requires some preliminary consideration, and may be determined on the basis of Moseley's principle of least resistance. The late Professor Rankine, in his "Applied Mechanics" (p. 215, Article 196), thus states this principle.—"If the forces which balance each other in or upon a given body or structure be distinguished into two systems, called respectively 'Active' and 'Passive,' which stand to each other in the relation of cause and effect, then will the passive forces be the least which are capable of balancing the active forces consistently with the physical condition of the body or structure."

Now it is clear from this statement that the best curve to select is that which produces the least horizontal thrust.

If a rope is stretched between two points so that the deflection is one-fourth of the span, and a similar rope is stretched in the same manner so that its deflection is half the span, it will be evident that the rope which has the least deflection, or which is stretched the tightest, will have the greatest horizontal stress, and it will be found that the horizontal stress varies in an inverse proportional to the deflection of the rope, so that the rope with half the deflection will have twice the horizontal stress of the other. Any rope, whatever the span, must theoretically have some deflection, even when unloaded, such deflection being due to its own weight,

> "There is no power, however great,
> Can pull a cord, however fine,
> Into a horizontal line
> That shall be absolutely straight."

These conditions will be exactly the same for an arch, and will determine the position of the curve according to Moseley's principle,—that is to say, the curve to be selected is that with the greatest rise and least span. As the middle third has already been fixed for the limit of the curve, it is obvious that the greatest rise given to the curve must be the outside limit of the middle third, and the least span the inside limit of the middle third.

In selecting the curve, it may be found that a curve which touches the middle third at the crown and springing will be outside the limit at some other point, and we may be able to bring it everywhere within the limit by slightly moving the crown and springing further inside the limit. In that case the curve, which falls everywhere within the limit, and which approaches nearest to the limit both at the crown and the springing, will be the curve to be selected.

To approximately determine the depth of the arch-ring at the crown, we can apply empirical formulæ founded by Rankine on the dimensions of good existing work.*

They are as follows:—

Depth of keystone for a single arch in feet

$$= \sqrt{(\cdot 12 \times \text{radius at crown})}.$$

Depth of keystone for an arch of a series in feet

$$= \sqrt{(\cdot 17 \times \text{radius at crown})}.$$

The depth of an arch-ring does not depend upon the crushing strength of the material so much as upon the curve of equilibrium, which usually requires wide limits to provide for the necessary stability, and thus gives an area many times greater than is required to resist direct crushing,—in practice the proportion has varied between 3 and 70, but the above formulæ by Rankine are based upon examples varying from 20 to 40.

Having approximately designed an arch, the curve of equilibrium can be drawn; but should the required conditions not be satisfied, the design will require modification, either by increasing the depth of the arch-ring, altering the rise, or altering the loads on the arch.

To construct the curve of equilibrium the horizontal axis of the arch (fig. 5) must be divided into a convenient number of parts, and the vertical weight calculated for the load on

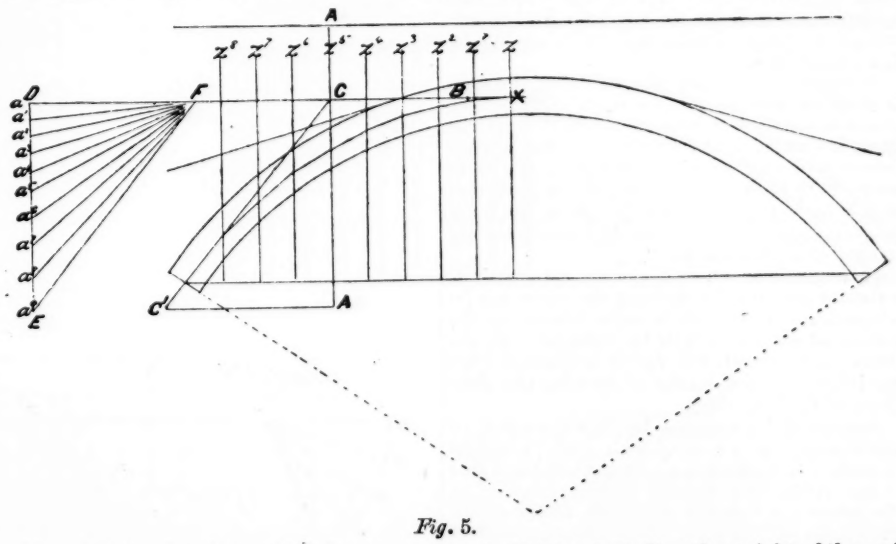


Fig. 5.

each division, including the weight of the arch. Through the centres of these divisions let the several lines marked z, z, z, be drawn representing the centres of effort of the load. Line A A represents the position of the centre of gravity of the whole of the loads on the half-arch, and is obtained by taking moments round the point in the springing selected for the curve of equilibrium to pass through,—that is, by multiplying each weight in the half-arch by its horizontal distance from this point in the springing, and dividing the sum of these products by the sum of the loads, we obtain the horizontal distance of A A from the springing-point round which moments were taken.

For arches having symmetrical loads upon each side of the centre it will only be necessary to determine the curve for half the arch, as both sides will give the same result.

From the upper limit of the middle third, X, at the crown of the arch, draw a horizontal line until it cuts A A in C. This will represent the direction of the thrust at the crown, which will always be horizontal under the influence of symmetrical loads. Then from point C draw line C C′ through the inside limit of the middle third at the springing. Lines C′ C and C X will form a polygon in equilibrium, supposing all

* Rankine's "Civil Engineering" (Tenth Edition), Art. 290.

the loads in the half-arch to be acting at their centre of gravity, and thus the direction of the thrust at the crown and at the springing is determined. To find the amounts of these thrusts, from C plot downwards, with the use of a convenient scale, a length C A equal to the sum of the loads upon the half-arch, and from point A draw A C′ parallel to C X until it cuts the oblique line in C′, then the lengths C C′ and C′ A will measure the amount of thrust at the springing and at the crown respectively. Let X C be produced to any point D, and from D set off a length D F equal to C′ A, and a line D E drawn downwards equal to C A vertically to represent the sum of the loads on the half-arch, then D E can be divided into parts $a\,a'$, $a^1\,a^2$, equal respectively to loads z, z^1, z^2, remembering to commence with the load nearest the crown. Then the vector lines drawn from the point F through a^1, a^2, &c., will give the elements of the polygon required to form a curve of equilibrium, and the stress in any part of the arch can thus be arrived at graphically.

To construct the curve of equilibrium draw from the point X, which is the point of intersection of the thrust at the crown with the first load z, a line parallel to a^1 F until it cuts the next vertical line z^1, and from the point thus obtained draw a line parallel to a^2 F to the vertical line z^2, and so on until the curve is completed. If this be done correctly, the line parallel to the line a^6 F will exactly join up at the point of intersection of C C′ with the springing. The amount of these forces at any point in the arch can be found by scaling the vector lines a F, a^1 F, &c., in the force diagram. It will not always be possible to obtain a curve which will fall within the proper limits at the first trial, although this may not render necessary any alteration to the arch. An example of this is shown in fig. 6, where the curve on the right-hand side, although brought to the centre of the limit at the crown and springing, is seen to be outside the middle third about half-way up the haunches, while on drawing a curve as shown on the left-hand side, where it touches the inside limit of the middle third at the crown and springing, it will be seen to pass everywhere within its proper limits, and will therefore be the true curve to select.

It will be noticed that the weight of the arch is divided into an even number of parts, but this is not at all necessary, although it simplifies the calculation. If the weight had been divided into an odd number of parts, one of the parts would have been at the crown of the arch, and would have required halving before the force diagrams were drawn, as half of it would belong to each side of the arch.

If the loads on an arch are not symmetrical, a similar method of obtaining the curve can be adopted, but it is a little more difficult, as the curves on each side will be different, and the thrust at the crown will not be horizontal, thus involving the extra labour of drawing the force diagram for both sides.

Suppose it be required to draw the curve of equilibrium for a span of 36 ft. (fig. 7), loaded at each of the points z, z, z on the left-hand side of the crown, with weights of two tons, and at the points z, z, z on the right side of the crown with loads of four tons. The difference in this case is that the curve is to be found for the assumed loading, and the arch designed to suit the curve, whereas the previous case was one in which the arch was designed at the outset.

The loads on the whole of the arch may be assumed to act at their centre of gravity A A without altering the reactions of the abutments. The distance of A A from either abutment equals the sum of the loads multiplied by their horizontal distances from the abutment from which A A is to be measured, and divided by the sum of the loads.

The stress polygon for the whole of the loads acting at A would be two straight lines drawn from Y and Z to any point in A A, and their direction would also be the direction of the tangents at the springing of the curve of equilibrium for the loads acting at their true positions.

Extending the method a little further, we can find the centres of gravity B B and C C of the loads between A Y and A Z, the segments into which A A divides the arch.

If the rise of the proposed arch is already fixed, the line of thrust must pass through that point, so that in the case of the load being concentrated on line A A the height of the point X would equal the rise of the arch; but by assuming the load concentrated at B B and C C the height of X must be such that a line drawn through the points of intersection W, W¹ of X Y and X Z with B B and C C will pass through the fixed height V at the crown of the curve. The height of X can thus easily be arrived at after one or two trials.

The stress polygon for the load acting at the two points upon each side of the crown will be Y W, W W¹, W¹ Z, which indicates the direction of the thrust at the crown and springing.

Let W W¹, the direction of the thrust at the crown, now be produced to any convenient distance, D and E, and from the points D and E draw vertical lines indicating the direction of the loads, and each equal in length to the sum of the loads on the half-arch to which they correspond.

From F and I draw lines F G and I H parallel to Y X and X Z.

The lines D G and H E will be equal to, and will measure the thrust at the crown, while F G and H I will measure the thrust at the springing points Y and Z respectively. Divide D F and E I into parts $a\,a^1$, &c., equal to the separate loads z^1, z^2, z^3, &c, commencing with the loads nearest the crown, and bearing in mind that each diagram corresponds to the half of the arch on which it is drawn; then lines a H, a^1 H, a^2 H, &c., will be the elements of the curve of equilibrium which can be constructed by drawing lines parallel to them between the lines z^1, z^2, z^3, &c., as in the previous example.

Another problem which occurs in practice is the consideration of an arch acted upon by oblique pressure in which the horizontal thrust is not constant throughout, as in the case of an arch acted upon by vertical pressure, but changes from point to point.

Let fig. 8 represent an arch acted upon by oblique pressures, equal in magnitude, and everywhere normal to the arch. In this case the loading on both sides of the arch is symmetrical; therefore the curve for one half only need be drawn, as the thrust at the crown will be horizontal. The resultant pressure of the loads upon the half-arch being inclined, each load must be resolved both vertically and horizontally before it can be properly determined. From any point z (diag. No. 2, fig. 8), draw lines $z\,y$, $z\,y^1$, &c., parallel and equal to the pressures z, z, z on the arch, from y, y^1, y^2, &c., let fall perpendiculars cutting the horizontal line X Z in the points 1, 2, 3, &c.: then the horizontal lengths z 1, z 2, &c., will measure the horizontal components, and the vertical lines Y 4, Y¹ 3, &c., will measure the vertical components of the forces to which they correspond. This may be drawn to any scale. The point through which the resultant passes can now be found by taking moments with the horizontal and vertical components of the forces round the springing point F, and thus fixing both the vertical and the horizontal distance of this point. The sum of the products of the horizontal components into their vertical heights from F, divided by the sum of the horizontal components of the forces, will give the vertical height of the resultant, and its horizontal distance can be obtained in a similar manner.

These two distances are next plotted on the diagram, and are found to intersect in the point A.

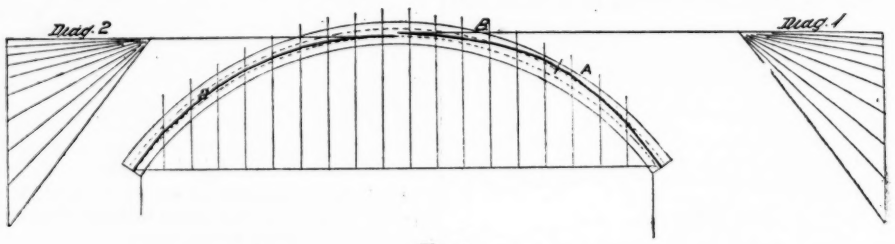


Fig. 6.

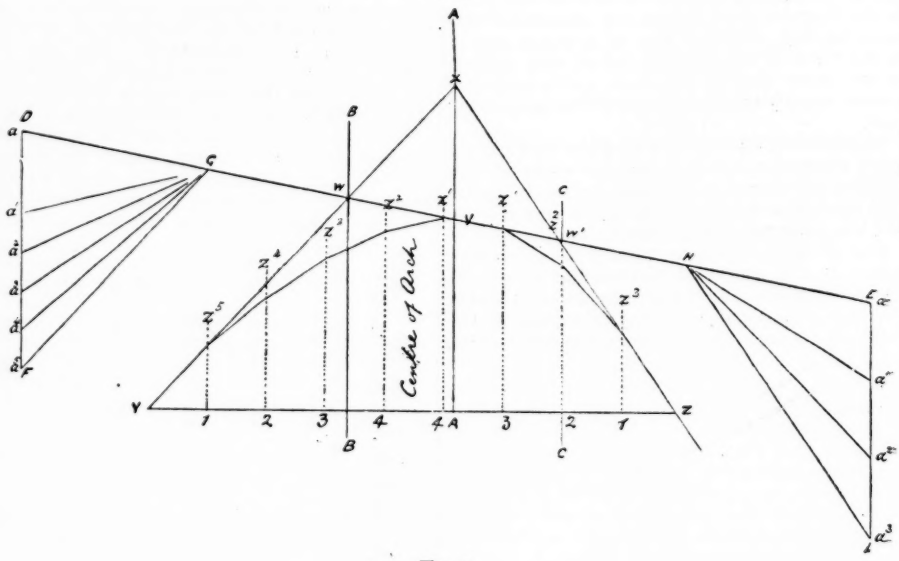


Fig. 7.

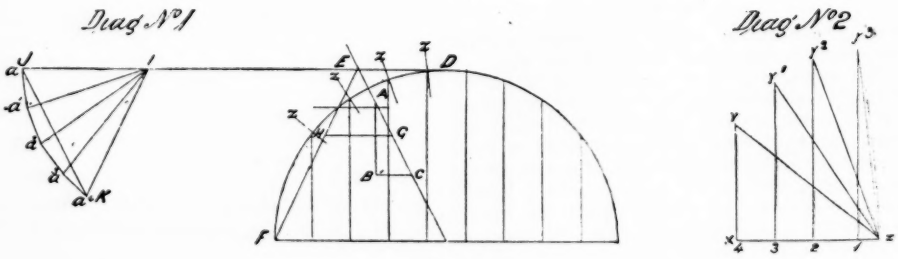


Fig. 8.

From A (fig. 8) the line A B, equal to the sum of the vertical components of the loads, is plotted downwards, and from B thus found the line B C is plotted horizontally, equal to the sum of the horizontal components; the oblique line passing through A C gives the direction of the resultant pressure of all the forces upon the half-arch, and its magnitude is represented by the length between A C.

The line of pressure D E at the crown of the arch is in this case horizontal, and is drawn through the oblique resultant, cutting it at E, and from E the line E F is drawn, which indicates the direction of the thrust at the springing.

To find the magnitude of the thrust at the crown and springing, make E G equal to A C, and from G draw a horizonal line cutting the line E F in H. E H will then measure the thrust at the springing, and H G the thrust at the crown.

The curve of equilibrium for each weight acting separately can be obtained by drawing

diagram No. 1 (fig. 8). D E is produced to any point J, and from J, J I, J K, and K I are set off, to any convenient scale, equal and parallel to G H, E G, and E H respectively. The line J K, being equal and parallel to the resultant of the external forces, lines $a\ a^1$, $a^1\ a^2$, &c., parallel and equal to the external forces $z\ z$, &c., should exactly join up between J and K when drawn in the diagram; if they fail to do so some mistake has been made either in calculating the resultant, or in draughtsmanship. The vector lines drawn from I through a^1, a^2, &c., will give the elements of the curve of equilibrium which are drawn between the lines $z\ z$, &c.

In this case the lines of force $z\ z$, &c., do not coincide with the vertical ordinates, so care must be taken not to draw the curve between the verticals, but between the oblique lines $z\ z$, &c.

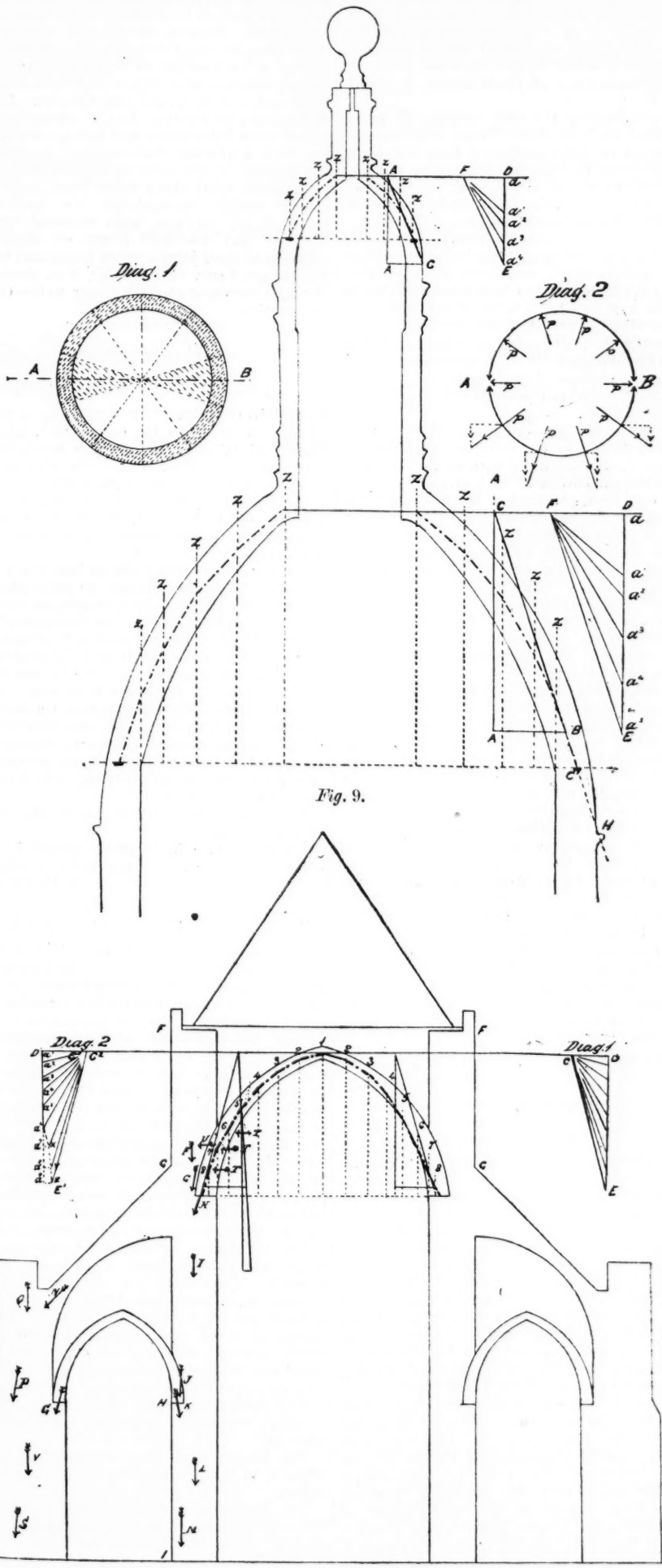


Fig. 9.

Fig. 10.

A dome is essentially an architectural structure, and fig. 9 shows a vertical section through a dome to illustrate the application of the foregoing theory to complex examples.

Although most of the foregoing diagrams may also refer to engineering as well as architectural work, they are of quite as much interest to the architect in illustrating the theory as if other more familiar examples had been chosen.

Diagram 1 of fig. 9 represents a plan of a dome which, for purposes of calculation, has been divided into ten parts by radial lines, and the weight is taken for any one of the portions, such as that shaded in the diagram, which, in principle, becomes the same as the arch.

The transverse section shown in fig. 9 is taken through A B on plan. The load is assumed to act at five points on each side of the centre, as shown in the vertical section, and the nearest points upon either side of the centre are so arranged as to be directly under the walls of the tower above. The cube measurement of the masonry carried at each point is found by measuring its thickness on the section, and multiplying it by the corresponding width between the radial lines on the plan.

The stress diagrams are worked in precisely the same manner as fig. 5, and therefore will not need further description.

The point to be noticed with regard to this structure is that the dome itself is perfectly stable, as the curve of equilibrium is everywhere well within the limits of the middle third, while the walls which support the dome would be thrust outward and cause the dome to collapse were they not strengthened in some way to resist the outward thrust.

The overturning action is indicated by the direction of the thrust C C upon the right-hand side of fig. 9, which will be seen to cut the extreme edge of the wall at H. This should be within the middle third of the wall to ensure stability.

It will be noticed that the curve of equilibrium does not commence at the springing of the dome, but at a point C′ some distance above it. The reason for this is that a chain forming a belt round the dome was assumed to act at this point, it being foreseen that the conditions of stability could not be fulfilled without this addition. This chain fixes the position of the curve of equilibrium at the springing, and resists the horizontal component of the thrust C C′, so that the thrust below the chain is all vertical and fulfils the required condition of stability.

The stress in the chain is very easily arrived at, as the plan, diag. 1 (fig. 9), was divided into ten parts, two of which were considered to act as an arch, the pressure C B at the springing (fig. 9) will act at ten points round the dome, and the horizontal component A B in this figure will be the pressure on the chain at each point P, P, &c., diag. 2 (fig. 9). For purposes of calculation, the chain is assumed to be divided at A and B, and the thrusts P, P, &c., resisted by two forces indicated by the arrows at A and B. Each thrust P is resolved into components drawn parallel and at right angles to the direction of tangents to the curve at A and B, so that the sum of the tangential components will equal the sum of the tensile stresses in A and B—that is to say, $\Sigma\ f = 2\ S \therefore S = \Sigma \frac{f}{2}$ where f = tangential components of the forces P, and Σ = sum, and S = stress in the chain.

Fig. 10 represents a section similar to that of Salisbury Cathedral, which the author has included in this paper to show the application of theory to the vaults, and the influence of the oblique thrusts on the side walls. The curve of equilibrium due to the weight of the arch alone is shown on the right-hand side of the figure, and might be considered by many as decidedly unstable, as the curve passes outside the intrados of the arch; but before the question as to its stability is decided, the influence of the wall above the springing must be considered.

In diagram 1 of fig. 10 we have the elements shown from which the curve above alluded to has been drawn.

In a very able paper read at the Institution of Civil Engineers, entitled "The Stability of Voussoir Arches," by Mr. Henry A. Cutler, Assoc. M.Inst.C.E., special attention was called to this influence, and an original method of calculating its effect given. This method being easily understood may be applied to the example now under consideration.

The curve of equilibrium approaching the intrados between the crown and springing, the arch would be thrust outward, but the wall between F and G would, if heavy enough, prevent

such outward movement and modify the curve to a considerable extent.

It will be seen that only the points 6, 7, and 8 will come into contact with the wall, so that above those points the loads on the arch will be unchanged. To ascertain whether the wall F G will make the arch unstable or not, it is best to modify the curve, and ascertain first what forces are required to balance it.

At point 5, upon the right-hand side of the diagram, the curve is too close to the intrados, but as the weights 1, 2, 3, 4, and 5 are definite and unalterable, the only way of altering the curve down to this point is to alter the horizontal thrust in the diagram—that is, to extend the line D C to an amount which cannot be ascertained definitely at first, but must be arrived at tentatively.

The extra thrust occasioned by this alteration will be supplied by the wall F G at points 6, 7, and 8.

It may appear arbitrary to suppose that the wall will exert the required pressure to make the curve of equilibrium fall within its proper limit; but, as noticed, the arch will be thrust out by the curve falling below the intrados, until it is brought to rest by the reaction of the wall F G behind it, and its reactive force (supposing the wall to be strong enough) restores equilibrium in the arch, thereby keeping the curve of equilibrium within proper limits.

Until the effect of the wall has been calculated, it can be only a supposition that the wall will be strong enough for this purpose, but this will be determined when the proper curve has been selected.

As a trial, the point C^1 in diagram 2 (fig. 10), corresponding with C in diagram 1 (fig. 10), may be moved to C^2, the same load-line D′ E′ being used as for diagram 1. The curve, as far as load 5, shown on the left-hand side of the arch, is the result, and this being seen to be so far sufficiently within the limits, the remaining portion of the curve between 5 and the springing is then assumed, and drawn so as to be within the limits and the lines a^6 c^3, &c., in the diagram drawn parallel to the lines in the curve, a method exactly opposite to the ordinary plan of procedure. From points a^7, a^8, a^9 horizontal lines were drawn until they cut the vector lines from C^3 in points x, y, and z, and then lines connecting these points gave the directions and amounts of the forces required to balance the curve.

By the construction of the diagram, lines a^6, a^7, &c., representing the vertical loads, become the vertical components of the oblique forces required, therefore the horizontal components are the extra forces required to obtain the modified curve or the thrust the arch exerts against the wall.

In fig. 10 these forces are indicated by the horizontal arrows T T T, and the resultant of the three, which is obtained by taking moments round the springing, is shown by the arrow marked U.

The weight of the wall F G acts at its centre of gravity F, and from the point of intersection of this line with U (the resultant of the horizontal pressures at 6, 7, and 8), the weight of the wall F G is plotted vertically downwards, and from the point so found an amount equal to the horizontal resultant U is set off; then a line connecting the two points so found is the resultant pressure on the bed-joint at G. This resultant is well within the limit of the middle third of the wall; therefore the whole structure is perfectly stable above the point considered.

The horizontal thrust at the springing is equal to D^1 C^1, the portion C^1 C^2 = U, being already provided for. The wall being assisted to resist the thrust of the arch by the flying buttresses, as a preliminary step some assumption must be made for the amount of thrust supported by it. The author has assumed that half the thrust is taken by the buttress and half by the wall of the building; this assumption brings the resultant pressures within reasonable limits, and is therefore not far from the truth. On finishing the calculation, had either of the resultants in the buttresses approached dangerously close to the face while the resultants in the wall were well inside, it would have been evident that half the thrust of the arch (assumed to act on the abutments) was too much, and a smaller portion would have had to be taken.

In a badly-designed structure it might be impossible to make the resultant in the buttress and also in the walls fall within the middle third, thus involving a necessary increase in the stabilty of the structure.

It being ascertained that the structure is stable down to point G, the portion between G and H is next considered, as at point H the thrust from the vault of the side aisle must be taken into account. At this point we have three forces acting (neglecting for the present the thrust from the side vault), the resultant at G, the thrust H from the main vault, and the weight of the wall between G and H acting at its centre of gravity, I; the direction and position of the resultant of these forces is shown at J.

Next considering the wall between H and I at the base, we have three forces acting on the bed-joint at I,—the resultant J from the upper wall, the thrust K from the side vaults, and the weight of the wall H I acting at its centre of gravity L; the direction and position of the resultant of these forces is shown at M.

It will be noticed that all the resultants indicated by the arrows are, if not within the limit of the middle third, very near to it, so that stability is insured if the buttresses are able to resist the assumed half-thrust of the main arch together with the thrust of the side arch.

Assuming the half-horizontal thrust from the arch to be conveyed through the centre of the wall in an oblique direction, parallel to the coping, its direction and position will be indicated by N (see fig. 10).

Considering the pressures on a joint at K upon the left-hand side of the buttress, we have the resultant N, the weight of the wall J K acting at its centre of gravity of O, and the resultant of the two forces indicated by P. The pressures acting at the lower joint L are P the resultant from the upper wall Q, the thrust from the arch and the weight of the wall K L acting at its centre of gravity V; the resultant of these forces is indicated by S. It will be seen that the resultants in the buttresses are well within the wall, and the whole of the structure stable; therefore the first case of failing stated at the beginning of this paper will not here exist.

The second cause, the crushing of the stones, need not be inquired into, but the third cause of failure, the sliding of the stones at the bed-joints, might exist, although in the case under consideration it does not. The angle of friction—that is, the limiting angle at which a pressure might be applied to a stone without its sliding on the stone beneath—varies from 31 deg. to 35 deg. with the normal to the joint, and if either of the resultants makes a greater angle with the normal there would be a danger of the stones sliding. The coefficient of friction is the tangent of the angle of friction, and for masonry is known to have a value of from ·6 to ·7. In some text-books we are furnished with the angles, and in others with the coefficients, but it is a matter of indifference whether we have the angle of friction or the coefficient for any particular material, as we can, when we know the meaning of the terms, derive one from the other.

[Some notes of the discussion which followed will be found under another heading.]

OBITUARY.

Mr. Pearson Barry Hayward, Architect, Exeter.—On the 15th inst. the remains of this well-known architect were interred in the Exeter Cemetery. Mr. Hayward was born on November 1, 1838, and was the son of Mr. John Hayward, of Exeter, the senior architect in the West of England. For many years they practised together, under the style of Hayward & Son, but latterly Mr. Tait, of London, has joined partnership, and the firm is at present known as Hayward, Son, & Tait. After serving his articles Mr. Hayward was for some time with Messrs. Hadfield, Weightman, & Goldie, of Sheffield (now Hadfield & Son), and returning to Exeter, built, in conjunction with his father, the Albert Memorial Museum, in Queen-street. He was also for many years Commanding Officer of the Exeter Company of the 1st Gloucester Volunteer Engineers; was Honorary Secretary of the local School of Art; and Curator of the Devonshire Diocesan Architectural Society. Amongst the many works Messrs. Hayward & Son have carried out, may be mentioned the Church of S. Michael, at Beer; the new Blundell's School at Tiverton; the High School for Girls, and the Diocesan Training College in Exeter. Mr. P. B. Hayward, senior, is a nephew of the late Sir Charles Barry, and he is also, we are told, a connection of Mr. J. L. Pearson, R.A.

Mr. Samuel Harpur.—The death is announced of Mr. Samuel Harpur, of Merthyr Tydfil. The deceased occupied the position of Surveyor to the Borough of Derby from 1841 to 1857. In the latter year he resigned, and entered into partnership with the late Mr. Tomlinson, of Allestree, and his brother, the firm being styled Tomlinson, Harpur, & Harpur, contractors. According to the *Derbyshire Advertiser*, they carried out a number of important water and sewage schemes at Ashby-de-la-Zouch, Burslem, Knighton, Coventry, and other places. In 1859 he removed to Merthyr Tydfil, where he completed some large water and sewage works. He was then appointed Surveyor and Engineer to the Merthyr Tydfil Local Board, which position he retained until about three years ago, when failing health necessitated his retirement, although his services were retained by the Merthyr and Aberdare Board of Health as engineer to their joint sewage farms and works. His youngest surviving son, Mr. Wm. Harpur, is Borough Surveyor and Engineer to the Cardiff Corporation.

Illustrations.

DESIGN FOR A FIREPLACE.

THIS is designed for a room in a private dwelling to be called "St. George's Hall," and the fireplace represents on the cresting St. George and the Princess and maidens of Egypt. Below, in the centre panel, is the legend of St. George. In the sides, St. Andrew, St. Patrick, St. David, St. Denis, St. Antony, St. James,—the traditionary seven champions.

The six figures under niches are the Virtues, the winged children, Genii, or good thoughts, the mounted Knights, Knight-errants.

The inscriptions are:—"St. George for Merry England"; the "whole armour" of the Scriptures (which were the virtues typified by the consecrated armour of Knights in the Middle Ages); and the famous "Honi soit" of the Knightly Order of St. George (the Garter).

On the marble portion are the nine worthies, David, Joshua, Judas Maccabæus, Hector, Alexander, Julius Cæsar, Charlemagne, Arthur, King of Britain, Godfrey de Bouillon. The figures on the flanks are sentries.

The hood over the fire represents the triumph of Constantine.

There are two ingle seats lighted by small windows, and by metal chandeliers at night.

J. H. POLLEN.

DECORATION FOR A DRAWING-ROOM.

THE drawing-room of which we give the ceiling and side forms part of an addition to a country mansion, the billiard-room, of which we hope to give an illustration hereafter, occupying the remainder of the ground-floor.

The woodwork of the dado, doors, and windows is of Australian black wood. The twelve pilasters are of pale mahogany, with panels of satinwood, inlaid with ivory and black. The capitals in the room are carved in mahogany, while those to the bay windows are of bronze; the pedestals of the pilasters have ornamental bronze panels, the frieze of the folding doors is of black wood, carved with dragons and the apples of the Hesperides, and has in the centre shield a marble jewel. The face of the archivolts of the recesses and their soffits are carved in mahogany, and the spandrels are painted with figures on a gold ground. The door plates and handles are of copper, inlaid with pale brass in scroll work; beyond the carpet the floor is of inlaid parquetry in scroll work of pale satinwood on a black ground, with walnut edges and white lines, and the room is hung with damask satin of pale apricot on a copper-coloured ground.

The ceiling, cornices, and soffits are plaster in relief, with figure panels of the Winds, Seasons, &c.

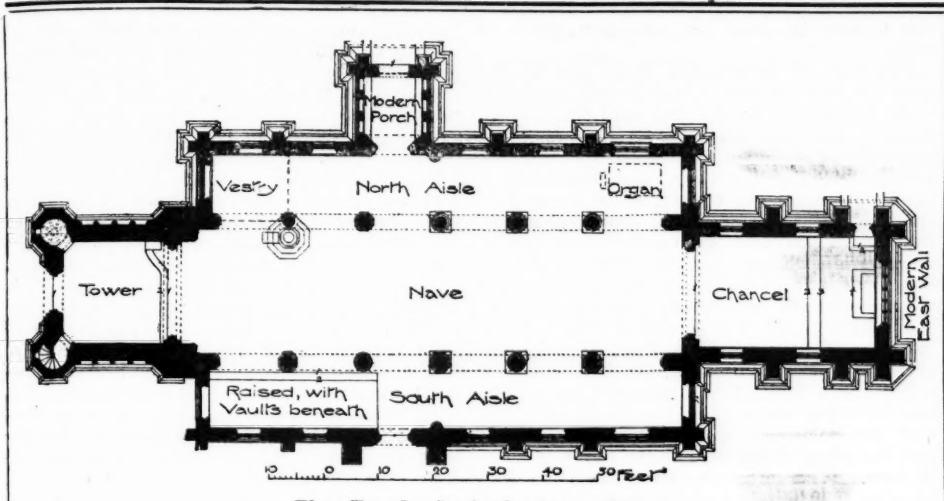
The bronze work was executed by Mr. A. Gilbert, A.R.A., from Mr. George Aitchison's design.

The figures of the Winds and Seasons, and the white marble chimney-piece and bas-relief over it, are by Mr. S. Pepys Cockerell.

DESIGN FOR A RAILWAY STATION.

THIS design, by Mr. W. H. Boney, was made in competition for a Royal Academy prize, and we commented on it, with others, at the time the students' designs were exhibited.

The design was not successful in the students'



Elm Church, Cambridgeshire.—Plan.

competition, but the Academy thought it worth a good place in the Architectural Room at this year's exhibition.

ELM CHURCH, CAMBRIDGESHIRE.

THIS church, which is dedicated to "All Saints," is situated in a village of the same name, about two miles from Wisbech. It is mainly of Early English work, though there are many evidences of insertions of later date, as the Decorated and Perpendicular windows in the north and south aisles testify. Although hardly so rich in detail as many of the neighbouring Marshland churches, it has some interesting features worthy of study, more especially the fine tower, nave arcading and clearstory, with its rich roof, and the north and south entrances. The plan is very simple, and seems to have been little altered from the original. The tower is at the west extremity of the church, and forms the principal entrance, leading to the nave, with its north and south aisles and chancel. There is no vestry, nor are there traces of a past one. At present the west bay of the north aisle is partitioned off and used as a vestry. The nave, of six bays, with a fine clearstory, is simple Early English work, the columns being alternately circular and octagonal. The chancel and tower arches are also of work of the same period. The nave roof is Perpendicular, of double hammer beam construction, and is very rich in carved and moulded work, much of which has fallen into decay. The north aisle has also a good, although simple, roof. The chancel has been much "restored," the east wall having been rebuilt, with a new Decorated window inserted; while a new roof has replaced the old one. The Decorated windows in the north and south walls are parts of the old work. The priests' door in the extreme north-east corner of the chancel is also an interesting feature. The tower is a very simple but bold example of Early English work. The richly-moulded north and south doorways are also worthy of note. The masonry generally is in excellent condition, especially that of the tower, clearstory windows, north and south doorways. The stone used is from the quarries of Barnack, in Northamptonshire, the same as used for Ely and Peterborough Cathedrals.

SIDNEY K. GREENSLADE.

*** We may add that the drawings here published obtained for their author the Neale Prize, presented by the Architectural Association for measured drawings drawn on the spot.

Association of Municipal and Sanitary Engineers and Surveyors.—The following gentlemen having satisfied the examiners at the examination held in London on the 26th and 27th October, have been granted certificates of competency by the Council of the Association:—R. R. Brown, Bridlington Quay; W. G. Bryning, Liverpool; W. C. Field, Eastbourne; J. T. Hawkins, Chichester; J. S. Millington, Wavertree; J. B. Wilson, Cockermouth. The next examination will be held in London in April, 1889.

The Annual Report of the Local Government Board.—We are compelled by want of space to hold over until next week our customary review of the annual report of the Local Government Board.

THE ARCHITECTURAL ASSOCIATION.

THE third meeting of this Association for the present session was held on the 16th inst., in the meeting room of the Royal Institute of British Architects, Mr. Herbert D. Appleton (President) in the chair.

The Hon. Librarian announced several donations to the library, one being a very valuable folio volume, "The Abbey of St. Andrew, Hexham," presented by the author, Mr. Charles Clement Hodges. Votes of thanks were accorded to the different donors.

Mr. T. E. Pryce (Hon. Sec.) stated that Mr. Millard had kindly undertaken to conduct the Elementary Class of Water Colours. He would be glad if members who wished to join that class, or the senior class, would send in their names as soon as possible.

Mr. C. H. Brodie said that at a meeting held for the purpose, a social club, with the title of the "A. A. Lyric Club," had been started for members of the Association. A committee had been appointed, with Mr. Appleton as President, and Messrs. Julian and Miller as Vice-Presidents. The object of the club, as stated in the rules, was "to promote friendly intercourse between the members of the Association," and one of the means would be the holding of a series of smoking concerts, the first of which would take place at Anderton's Hotel, Fleet-street, on the 8th prox. It was proposed to hold two meetings monthly, on the first and third Thursdays, the session of the club to be concurrent with that of the Association. The subscription would be 5s., and after a certain number of members had been elected, a small entrance-fee would be charged. The club had the sympathy of, and would work in co-operation with, the Entertainments Committee.

Mr. A. T. Walmisley, M.Inst.C.E., then read a paper on "The Theory of Arched Structures," which, with the numerous diagrams illustrating it, we print in other of our columns.

The Chairman said the paper was one that hardly admitted of discussion, and they could only sit at the feet of Gamaliel, and learn of him (applause). The subject had been most admirably explained, and when they had the benefit of the diagrams in connexion with the letterpress, they would be able to study them quietly by themselves. It might be difficult, in a great many instances, to follow this graphic method of calculating strengths if one was not accustomed to it, but Mr. Walmisley was to be congratulated on the extreme clearness of his expositions (applause). The subject ought to be one of great interest to architects, and he was in hopes that this mode of calculating thrusts and weights was growing in favour with them. Up to a comparatively recent time they had been in the habit of doing things too much by rule-of-thumb. If, therefore, they could give a reason for the faith that was in them, it was advisable they should do so.

Mr. H. Lovegrove, in moving a vote of thanks to Mr. Walmisley, remarked that this was a topic in connexion with which no burning question of partisanship for styles could be introduced. They were brought face to face with very difficult problems, and the diagrams would have to be thought over, as it was quite impossible for one to rise at a moment's notice and follow the lecturer through all his explanations; but if they could by any means see those diagrams, and ponder over them, they would learn very much which would be to their profit. He was very glad that Mr. Walmisley had referred to the part played by the chain round the dome, because he (the speaker) had recently had to consider the construction of a dome, and he was a little bit at sea as to the exact part played by the chain. He, of course, knew about it generally, but he had wished to know more particularly, and that information he had now received. He had often wondered how much their ancestors in the Middle Ages knew of these theories, when constructing their extraordinary groining, and he had sometimes fancied that they knew little about the theory, but put their work together with ample strength. Taking the roofs of the Middle Ages, they would be found, on critical examination, to be composed of massive timbers put together, and kept in place by the enormous thickness of the walls and buttresses. The Mediæval construction was not so scientific as that of some of the modern roofs, and Mr. Walmisley seemed to indicate that flying buttresses were almost necessary for groining of the kind shown, to divide the stress, as it were.

Mr. Percy Hunter seconded the vote of thanks. In listening to the paper, the same question referred to by Mr. Lovegrove had arisen in his mind, viz., as to whether the old builders ever worried themselves about all those strains and stresses so graphically represented that evening; and he believed, for the happiness of all present, they might arrive at the safe conclusion that the old men did nothing of the kind. He said for their "happiness," because if architects had to sit down to their drawing-boards and T-squares to work out all that sort of thing graphically before they could design a cathedral, they would throw up the work in despair. At the same time, as the President had said, they wished to give a reason for the faith that was in them, therefore they were glad that, owing to the advance of science and the careful attention given to those matters by Professor Rankine and others, men like Mr. Walmisley were to be found to whom they could safely go for advice and assistance in any question of really difficult construction. The author himself had given them some hopes of an escape from their difficulties in the designing of a beautiful building only by means of scientific construction, because he had admitted that Professor Rankine started first of all with some arbitrary assumptions. The Professor took the stability of existing buildings, and working from that deduced his wonderful method of arriving at results. He was very thankful after all that Professor Rankine had gone to the old examples, before he could arrive at his scientific results. They might compare it, in a certain degree, to the Grecian statuary. It was very doubtful if the Greeks had such a knowledge of anatomy as was possessed now-a-days by many of the students of the Royal Academy, yet they turned out beautiful statues. The old builders, too, had great ideas of beautiful buildings; but they could not have shown reason for the faith that was in them, and they therefore built from experience. That it was so, he presumed might be taken from the history of the buildings themselves, and from the way in which they had evidently dealt with different parts of their construction at a time, getting over the difficulties as best they could, by putting on something here, or taking off something there, and diverting their loads. In the section of the dome [see fig. 9 on p. 377], Mr. Walmisley had taken a two-centred arch, and he arrived at the thrust at the point C, which was counteracted by the chain. He supposed that Sir Christopher Wren would be quoted as the architect who set that example; but he would like to know whether, supposing it were a semi-circular dome, there would be any outward thrust. He had heard it doubted whether there was any thrust with a dome at all if it was truly constructed. Some time ago he heard a paper read by Mr. Chisholm, then architect to the Gaekwar of Baroda, which did not deal so much with the scientific construction of the dome as with the method in which it was built up with an absence of anything like centering. After the meeting he had a discussion with Mr. Chisholm upon the question of domes, and he found there was a great divergence of opinion as to whether there was any outward thrust at all with a truly-constructed dome. Mr. Walmisley had undoubtedly shown one thrust, and which certainly would appear to exist. To show how much engineers had worked by rule-of-

thumb, he would like to quote a well-known story of Mr. Brunel. An arch fell down during the construction of the Great Western Railway. Meeting the Board of Directors, who were in a great state of alarm and annoyance at the heavy loss, Mr. Brunel said,—"I am very glad of it." The directors inquired why, when Mr. Brunel replied,—"We were going to build twenty other arches exactly like this, but now we find we have made a mistake, and we shall have to alter them." It, therefore, would seem that all this arch-building had been done very much upon a rule-of-thumb principle. It had been a matter of experience; and while he was rather delighted to find this graphic method of representing on paper, and arriving at something approximating to truth, he still felt very sceptical about accepting it as final, because there were many influences which might happen to altogether upset the calculations. The weight might happen to get imposed in a certain way during the work, and by settlement or some other cause the whole thing would be altered. So that while he would like to have this method of arriving at the result scientifically, he would still venture humbly to enter a protest against accepting it as final,—the more so as Mr. Walmisley had stated that he first of all started from an empirical rule founded upon the experience of others.

Mr. A. O. Collard supported the motion, and expressed his admiration for Mr. Walmisley's paper.

Mr. Sydney B. Beale said he rose, not with the expectation of adding much that was new to the theories brought forward that evening, but to draw attention to the methods adopted in some of the diagrams exhibited for arriving at the curve of strain in an arch under given conditions of loading. It would be seen that in each case a funicular polygon had been constructed, outside and distinct from the drawing of the arch or vault itself. The curve of strain had been derived therefrom, and finally drawn upon the arch voussoirs. This method was much more simple, less laborious, and infinitely better in many ways than a certain method adopted by the majority of writers on the graphic delineation of forces. He referred to the system of constructing the curve of strain in an arch ring, by drawing a series of parallelograms, one for each voussoir,—the vertical loads, acting through their centres of gravity, being resolved, together with the thrust from the crown of the arch, into a resultant that had to be similarly combined with the weight on the next voussoir, and again resolved, the whole resulting in an indescribable mass of lines, representing bed-joints, weights, tnrusts, resultants, curves of pressure, and curves of resistance, radiating in all directions, much to the confusion of the investigator. The simplicity and clearness of the diagrams before them forcibly showed what an advantage the use of the funicular polygon had over the other method of many parallelograms in the determination of the curve of strain in an arch ring. Mr. Walmisley had described his inquiry into the stability of the nave-arching of Salisbury Cathedral. One half of his diagram (fig. 10, p, 377) indicated the curve of strain arrived at upon one series of calculations, and it was seen approaching dangerously near the intrados of the arch, and, in fact, intersecting it. That arch, undoubtedly, would contain an element of danger, were it not for the great assistance received from the weight of the superimposed nave-wall, carried up above the springing of the vault. Backing up the haunches of an arch added very considerably to the stability of the structure. That fact might be interestingly demonstrated by using a small wooden model of an arch ring constructed with hinged or flexible joints. Upon the application of an undue pressure on the model, whether in a vertical or oblique direction, the arch would collapse; but if the haunches of the model arch were pressed upon simply by the hands, the model, under a large accession of pressure, even applied at the most disadvantageous point, would remain perfectly rigid, without any indication of failure. It then was due to the backing-up of the haunches of the nave-arching of Salisbury Cathedral by the weight of the upper portion of the nave-wall that that fine old edifice had remained in a condition of stability to the present day (applause).

After some remarks from Messrs. Owen Fleming, W. Randolph, and H. Lanchester,

The Chairman having incidentally expressed a doubt whether the vaulting of King's College Chapel, Cambridge, could have been put up by people who had no correct knowledge of the thrusts in such an elaborate piece of work,

The vote of thanks was then put to the meeting, and met with a very hearty reception.

Mr. Walmisley, in replying, said that several remarks had been made as to the amount of scientific knowledge possessed by the old architects. Perhaps they had depended a good deal upon experiment, as in the case of the New-street Station roof at Birmingham. In that case a load was laid on at various points, to ascertain whether it would bear the strain; but now they could calculate the strains, and, if the material and the construction were proper, they could prove the results of the calculations, specifications, and drawings. The diagram of Salisbury Cathedral (fig. 10) was a section taken from a book which illustrated the edifice, and his object was to show the effect of the wall and the buttresses in sustaining the thrust, and the effect of the wall on the curve of equilibrium. With reference to the dome question, whether there was a horizontal thrust or not depended on the vertical loads of the curve of equilibrium. It was possible to construct an arch which should be too heavily loaded at the haunches, or at the groining. The superstructure above the dome had to be considered. The curve of equilibrium had to be drawn, and it was necessary to see that the weights were such that though there might be little horizontal thrust, there might be the chance of the arch coming out between the groining and the springing, which depended greatly on the weights they had to deal with and the rise they gave to the arch. One gentleman thought there was no tension unless the line of pressure fell without the wall. He thought he had sufficiently explained that by the illustration of the plank and the statement quoted from Professor Rankine.

The proceedings then terminated.

THE CULTS AND MONUMENTS OF ANCIENT ATHENS.

Miss Harrison's third lecture at the South Kensington Museum, on November 16, had for its subject the theatre of Dionysos at Athens. This theatre has been excavated since 1862, so that it would scarcely fall within the scope of these lectures were it not for the recent discovery of the ancient circular orchestra or dancing-place, and for the mythological importance of its sculptures in regard to the cults. Close to the theatre were the two temples of Dionysos mentioned by Pausanias (i. 20). The foundations of the oldest (*τὸ ἀρχαιότατον*) almost adjoins the stage — one proof that Greek dramatic performances were not a mere amusement, but had a sacred character. The theatre can best be studied under the three headings of the *theatron* proper, the stages, and the orchestra. The first was composed of semicircular rows of seats, rising one behind the other; only the places of honour were separate chairs, but the stone benches were distinctly marked off into divisions, so that each spectator had his allotted space. The chairs were set apart for the priests. The most beautiful of these exactly faces the stage; it belonged to the priest of Dionysos, and is inscribed Ιερέως Διονύσου Ελευθερεως. Another, of which the inscription was given in the last lecture, belonged to the priest of Hekete and the Charites. On a third we read 'Ιερέως | Ανάκων | καὶ ἥρωος | Επιτεγιος—a hero known to us from this inscription only.

Turning to the stage, or *skene*, we find that there were several stages built at various dates. The latest, constructed by the architect Phaidros under Septimus Severus, is supported by coarse figures of Sileni, alternating with reliefs representing the life of Dionysos. Poor though these sculptures be, they have great mythological interest; they give us the birth of the god, his reception by Ikaoros on his first entrance into Attika, &c. This myth of the journey of Dionysos means, of course, that the vine was not indigenous to the soil of Attika, but imported. The deme *Ikaria*, where the god first stopped on his journey, has within the last year been identified with Dionuso, to the north-east of Pentilikos, a beautiful spot, where the Dionysiac ivy still abounds, and where the numerous goats seem ready for sacrifice to the god.

When we come to consider the orchestra, we find that the several stages encroached on it to such an extent that its original circular shape was destroyed. The real gist of the orchestra is best understood from the plan of the theatre at Epidaurus, excavated 1881-3. It shows the perfectly round orchestra, the wide *parodoi* leading to it on either side, and the small stage. Miss Harrison holds that not only the chorus appeared on the orchestra, but that the greater part of the action took place there. She graphically showed the gain that this would be in such a play, for instance, as the "Agamemnon." The chariot bearing *Agamemnon* and *Kassandra*, and the whole train of captives, would come sweeping down the *parodoi* on to the orchestra; a great sense of space and freedom was thus gained, and the difficulties arising from the want of room, were such crowded action represented on the *skene* above, avoided. The *skene*, then, was of comparatively little importance in the early Greek theatre, and was used probably only when it was necessary to emphasise the fact that an actor appeared from *within* the palace or house, *e.g.*, in the case of the "Agamemnon," *Klytemnestra* issuing from the royal palace would appear on the *skene*. Lately the old pro-Lycurgic orchestra or dancing-place of polygonal masonry has been discovered in the theatre of Dionysos. It was the earliest and only permanent portion of the theatre in the days before the wooden seats had given place to the more substantial stone ones.

In the centre of the orchestra was the altar on which the goat was sacrificed, and round which the chorus danced. The whole drama arose in time out of the simple sacrifice and dance in honour of Dionysos. The earliest representation of such a dance is the archaic *choros* at Olympia,—seven quaint figures linked together for a round dance. The *choros* was not in honour of Dionysos alone. A fine vase (Corneto) shows a round dance disposed as a border around the contest of Herakles and Triton. In its special connexion with Dionysos, two new mythological elements came in,—the Satyrs and the Maenads. The beautiful cylix, by Hieron (Berlin), shows the Maenads dancing in honour of Dionysos *Dendrites*. An aryballos from Attika (Berlin) shows them reclining in every picturesque attitude of exhaustion after the dance. The riotous element of the Bacchic dances was intensified by their connexion with the rites of Kybele,—a connexion well proved by the first chorus of the *Bacchæ* of Euripides, and by a terra-cotta from Megale (St. Petersburgh), showing Kybele in a shrine, surrounded by a frieze of Maenads. These illustrations are only the mythical counterpart of what actually took place. The great *Krater* at Naples brings visibly before us the whole scene of the preparation for the chorus,—actors with their masks ready to put on, figures hurrying to and fro; in fact, all the scene of bustle which precedes a performance. The Dionysiac Theatre itself was adorned with dancing figures; two of extreme beauty,—one of a figure in calm movement, the other showing a Bacchante in excited motion,—are now in the Central Museum at Athens.

ARTS AND CRAFTS EXHIBITION SOCIETY.

TYPE-FOUNDING AND PRINTING.

In type-founding and printing, Mr. Emery Walker, who delivered his lecture on the 15th inst., was furnished with one of the most interesting subjects which could fall to the lot of a lecturer—one which affords ample material for picturesque treatment—and appeals to every class of hearer; for who ever tires of hearing about books? But it was too large a subject for a single lecture, and to do it the barest justice was in the circumstances a hopeless task.

The much-debated point of the inventor of printing was ingeniously disposed of, the lecturer remarking that the inventor of movable types was the real inventor of printing. He might have told his audience that there were grounds for believing that the Chinese (who were represented at the lecture) used movable clay types so early as the eleventh century—and that in the British Museum are certain Corean books so printed, and dated 1337. Our Norman Kings used what was in effect a movable type in the block with which they impressed their initials, and the wonder is how so obvious an advance as the multiplication of single letter blocks should have been so long delayed. But all great inventions are simple, like the conjuror's tricks when explained; and it was not until the prisoner had been for sixteen years in his dungeon that a happy thought struck him (*pace* Artemus Ward), and he opened the window and got out!

The first use of movable metal types, though often credited to Gutenberg, has been traced with reasonable certainty to Coster, of Haarlem,

in the year 1445, and the earliest extant example of their use is believed to be a Letter of Indulgence by Pope Nicholas V., dated 1454. The first types were facsimiles of the handwriting of the time, and they not only closely followed the shapes of the letters, but also the unevenness of the written lines. The printers were uneducated men, and copied with dull precision the MS. before them,—mistakes, erasures, and all. Improvement in the printers' art was very slow. Catchwords at the bottoms of the pages were introduced in 1469, pagination in 1471. Vellum gave place to paper in the same year, and in 1473 the lines were straightened by mechanical means, and the general appearance of the printed page became something like what it is now.

The lecturer rapidly explained the cutting of the steel letter-punches, the formation of the matrix, the casting of the type therefrom, the compositors' cases, and general arrangements of a modern printing office.

By the assistance of the oxyhydrogen light he threw upon a screen enlarged facsimiles of some early MS. and printed sheets in chronological sequence, and dwelt upon their points of difference and excellence with minute knowledge of the subject and the unction of an enthusiast.

Passing to the subject of book illustration, he insisted on the necessity for making the cut subservient to the text, and was very severe upon the modern practice of deranging the text in order to print a block of fanciful outline. In criticising the modern style of woodcutting and the use of toned pictures, he should have called to mind some notable exceptions—to wit, the early woodcuts of Sir John Millais and others; and the presence of Mr. Walter Crane might have reminded him of the charming illustrations to Mrs. Molesworth's tales which that accomplished and versatile artist has supplied, and which fulfil every requirement of the woodcutter and printer.

The lecturer had much to say as to the superior beauty of the older type, and commended the *Pall-Mall Gazette* and other papers for returning to the earlier fashion. He explained the reason for printing the text so as to leave a wider margin at the bottom and right-hand side, as they suffer most in wear, and altogether favoured the arrangement of title-page, &c., &c., which the sixteenth-century Italian and Flemish printers used.

The President having announced that bookbinding would form the subject of the next address, the company spread about the galleries, which were thrown open for their enjoyment.

THE IMPERIAL LAW COURTS AT LEIPZIG.

THE highest Appellate Court of the German Empire is not, as so many other things are, at Berlin, but at Leipzig, and the stress of business rendering larger buildings absolutely necessary, a competition,—public, but limited to German architects only,—was called for in the spring of 1885, with the result that the first premium was awarded to the Darmstadt Court architect, Prof. Ludwig Hoffmann. His design was recommended for adoption subject to certain alterations, and these having been made to the satisfaction of the law officers of the Crown, the whole scheme was finally referred to the "Architectural Academy of Saxony" for approval. This having been obtained, Prof. Hoffmann was asked to prepare an estimate of the cost. Early in 1886 this estimate was ready, and amounted to 322,750*l*., which, by successive curtailments in ornamentation and so forth, was finally reduced to 295,100*l*. The preparation of the details occupied the following year and part of this, and on October 31 the foundation stone of this important building was laid by the Emperor in the presence of the King of Saxony and a large legal and (of course) military gathering, the architect having the honour of personally explaining the plans to his Majesty at the close of the ceremony. The works are now in progress, but it is calculated that the carcass alone will take two years, and the joinery, internal fittings, and the lighting and heating arrangements will take four years more. A large model is now being prepared to show certain external alterations contemplated by the architect, and as soon as this is completed we hope to refer to this subject again, and to publish the plans obligingly promised to us by their author. In the meantime, we may add that the building stands, as such buildings should, entirely free on all sides, and that the general design consists of a rectangular plan of about two to one, with two large open courts formed by a cross-range from back to front. The elevation is in palatial Italian Renaissance, and consists of two storeys, the lower one low, with rustications and square openings, the upper one high, with round-headed windows, &c. The centre of the principal façade is broken by a slight but broad projection, with cupolas at the angles, and further central projection containing a grand entrance-archway. The central feature upwards is the large dome of the Great Hall, which is placed in the cross-range above mentioned, and, although naturally at some distance behind the line of frontage, it will not only be high enough to dominate the entire group, but will form a conspicuous object in the City of Booksellers.

ARCHITECTURAL SOCIETIES.

Birmingham Architectural Association.—At a meeting of this Association, held on Tuesday evening last, Mr. Herbert D. Appleton, F.R.I.B.A., President of the (London) Architectural Association, read a paper on "The Affiliation of Student Architectural Societies." It reached us too late for insertion this week.

Edinburgh Architectural Association.—At a meeting of the Edinburgh Architectural Association, held on the 15th inst., in the Architectural Hall, 42, George-street—Professor Baldwin Brown, president, in the chair—Mr. J. Crabb Watt delivered a lecture on "The Æsthetics of City Buildings." Selecting Edinburgh as a type to which the abstract principles, discussed in his previous lecture, might be applied, he proceeded to refer first to the burghal and then to the urban architecture. Under the first branch, he touched incidentally upon the recent Municipal Buildings scheme. With the exception of the site of the Bank of Scotland, the proposed situation he thought was the finest almost in Europe for such a purpose with respect to the base, elevations, and sky-lines. At the same time, his impression was that no buildings which did not exceed at least 200,000*l*. could ever afford satisfaction to themselves or pleasure to strangers, and certainly would not satisfy the requirements of æsthetics. In the second part of his subject he dealt at considerable length with the structure and features of the new town. At the outset he expressed regret at the evident unwillingness or obstinacy of the south side contingency of the Town Council to eradicate the source of disease and uncleanliness at the base of the new town. Dealing with the beauties of the architectural style of the buildings, he spoke of George-street as being the finest street he had seen in any town,—and said he had seen many towns here and in five Continental countries. Ruskin's criticisms of Edinburgh architecture received considerable attention from the lecturer, who thought that he had gone entirely astray in the views which he had adopted. He next spoke strongly in favour of the adoption of grotesque ornamentation to a greater degree than hitherto, but gave a word of warning against perpetrating vulgarism in stone, as at Brussels. Æsthetics, he said, above all things, demanded variety of perspective and pure taste in detail; and in his opinion they had a good deal to learn in regard to their cornices and the ornamentation of their front elevation. As a practical suggestion, he thought that an æsthetic council might be established, or the constitution and power of the Dean of Guild Court enlarged.

Leicester and Leicestershire Society of Architects.—A large meeting of members of this society and their friends was held on Monday last, when Mr. R. Phené Spiers, F.S.A., delivered a lecture on the "Structural Origin of some forms of Mohammedan Architecture," illustrated by drawings on the black board, and by an admirable collection of drawings and photographs. A vote of thanks, proposed by Mr. Jackson, seconded by Mr. Paget, and endorsed by the Chairman, Mr. Tait, was carried by acclamation.

Manchester Architectural Association.—The last ordinary meeting of this Association was held at the Diocesan Buildings on the 20th inst., Mr. A. H. Davies Colley, A.R.I.B.A., President, in the chair. Mr. J. Corbett read a paper on "House-heating Water-fittings," in which he explained the principles necessary to insure a perfect circulation, together with all necessary practical information. A discussion followed, in which Messrs. Mould, Stelfox, Hodgson, and Ward took part.

Sheffield Society of Architects.—At the ordinary monthly meeting of the Sheffield Society of Architects and Surveyors, last week, an interesting paper was read by Mr. E. J. Tarver, F.S.A., on "A Proposed Improvement in Theatre Planning." Mr. T. J. Flockton presided, and there was a large attendance of members and visitors, including Messrs. J. B. Mitchell-Withers, C. Hadfield (hon. sec.), J. D. Webster, W. F. Hemsoll, H. W. Lockwood, C. J. Innocent, W. C. Fenton (Buildings Inspector), J. Jackson (Chief Constable), H. Bramley, B. Cartledge, W. Maugham, and others.

COMPETITIONS.

The Friar's School, Bangor.—The Governors, acting on the advice of their assessor, have adopted the design "Light and Air," by Messrs. Douglas & Fordham, of Chester. The design "Stability," by Messrs. Oliver and Leeson, was, in the opinion of the assessor, next in merit. Designs were also sent by Mr. Burgess, Mr. Bell, Messrs. Giles & Gough, and by Mr. Grierson (of Bangor). The work will be carried out by Messrs. Douglas & Fordham, the non-successful competitors receiving each the sum of 20*l*. The six names were selected by the Governors from a list of twelve named by the assessor (Mr. R. Herbert Carpenter, F.R.I.B.A.) in answer to an invitation from architects of some experience in school buildings of the class proposed to be erected at Bangor. The plans will be on exhibition for a fortnight.

New Offices, Bute Docks, Cardiff, for Messrs. Cory Bros. & Co., Limited.—In response to advertisements, over fifty architects from all parts of the country, competed for the work, and the two premiums offered have been respectively awarded to Mr. E. H. Bruton, of Cardiff, and Mr. E. A. Lansdowne, of Newport, Mon.

Public Offices, New Swindon, Wilts.—At a meeting of the Local Board, held on Tuesday, November 13, the following gentlemen were the four selected out of twenty-seven competitors:—Mr. Brightwen Binyon, of Ipswich; Messrs. Henman & Timmins, of Birmingham; Mr. J. Beale, of Westminster; and Mr. W. H. Read, of Swindon. The final selection has now been made, allotting the first premium to Mr. Binyon, and the second to Messrs. Henman & Timmins.

LINES OF BUILDING FRONTAGE.

SIR,—I observe a reference in last week's *Builder* to the Report of the Royal Commission on the Metropolitan Board of Works, and to my suggestion as to the constitution of an Appeal Committee. It is there said that the "Commissioners entirely dissent from the suggestion of making the Superintending Architect a Member of the Tribunal of Appeal from his own decision."

I am sure you will oblige me by printing the actual words of the Report. The Commissioners say:—"His reasons for this suggestion will be found in his letter which is appended to our Report. We quite admit the weight of those reasons, but we think there are, on the other hand, objections to allowing the person appealed from to form part of the Tribunal of Appeal. We do not think it necessary to express any decided opinion on the point, but submit the whole matter as one deserving very serious consideration."

No doubt the objections at which the Commissioners hint will be carefully considered with my recommendation. I am, of course, quite indifferent as to the result.

THOS. BLASHILL,
Superintending Architect of Metropolitan Buildings.

*** The words "entirely dissent" are, we perceive, a little too strong; but the impression left on our mind was that the Commissioners' own opinion was decidedly against the suggestion. Our objection is, of course, on general principle only, not from any opposition to Mr. Blashill in particular.

THE "SUGGESTIONS" AND "HINTS" RE-ISSUED BY THE INSTITUTE.

SIR,—At the "business meeting" on Monday night I think it was overlooked that this re-issue, like the "Encyclical of the Antiquaries" (to quote Lord Grimthorpe), was intended, not only for members of the Institute, but for circulation among the rural deans and others of the clergy, who, with churchwardens, are more immediately responsible for the structures of our ancient churches. But

there are, as it is only too certain, some of us architects devoid of antiquarian knowledge, who sadly need the valuable advice given in these carefully-studied "Suggestions." This re-issue was, therefore, intended to remind *all* those concerned in the initiation and control of "restorations," that the Institute had been among the *foremost* in their earnest and practical advocacy of "conservation," which is now so strongly urged by the Society of Antiquaries, and by other, perhaps, less *practical* societies. A FELLOW OF BOTH SOCIETIES.

4, *Carlton-chambers*, 4, *Regent-street, S.W.*
Nov. 20, 1888.

*** Does our correspondent think the shaving off of the outer half of a partially-decayed mullion, and pinning a new front on to it, a very "practical" proceeding?

THE REVIVAL OF HANDICRAFT.

SIR,—Mr. Morris exhibits a sideboard and also a cabinet at the Arts and Crafts Exhibition, which he tells you in the catalogue are "designed by G. Jack." But the two men, Sidwell and Thatcher, who *made* these pieces of furniture, were not considered or mentioned at all until Mr. Crane asked for their names.

This little incident will amuse those who have heard Mr. Morris's tall talk about the place the handicraftsman is going to take when the Socialists' dream has been fulfilled. It does not appear to me necessary to wait for the revival of handicraft till we are all unselfish and industrious enough to make the fulfilment of these poetical ideas possible.

I think there can be very little doubt that it is principally the decadence of the apprenticeship system which is the cause of the degeneration of the handicraftsman, and that a return to this, coupled, of course, with a demand for artistic work, would very soon bring about a change. Mr. Morris denounces machinery, but, I would ask, cannot beautiful things be made by machinery, and is not the constant repetition of ugliness the fault of the manufacturer, who will not pay for good and fresh designs, and cannot judge them if he would, and of the buyers, who only like gaudiness and show, rather than the fault of the machine?

Mr. Morris asks people to notice "how beautiful the ordinary arts of life became in the Middles Ages," and says the reason was that the workman of that day was free. Why does not Mr. Morris free the men who do his work, and allow their names to appear, instead of their being merged in "Morris & Co."? CHARLES F. MOXON.

"F.S.A."

SIR,—Will you kindly permit me to state that Mr. Brightwen Binyon, whose name appears on a design in your issue of the 17th inst., although he signs himself "F.S.A.," is *not* a Fellow of the Society of Antiquaries of London.

W. H. ST. JOHN HOPE,
Asst.-Sec. S.A.

*** Since receiving this letter we have written to Mr. Binyon for an explanation, but up to the time of going to press have not received any reply from him.

WARMING VILLAGE CHURCHES.

SIR,—Referring to the letter of "An Old Subscriber," asking for information on the above subject, I am pleased to give him the result of my experience.

Last year I was consulted as to the best method of warming a village church near Southampton.

I had the same difficulties as your correspondent to contend with; a chimney was objected to, no water or gas supplies available, and a furnace outside the building was to be avoided.

After great consideration, I decided to adopt the system of hot air warming, as invented by Mr. John Grundy, of 30, Duncan-terrace, City-road, London, the *modus operandi* being as follows:—Two chambers were constructed of 9 in. brickwork, under the aisle floor near the entrance door; one 4 ft. by 7 ft., and the other 8 ft. by 4 ft., both 5 ft. deep; the former being the stoking-chamber and fuel-store, and the latter the air-chamber, in which Grundy's patent single apparatus was placed.

The cold air is conveyed into the heated chamber by three sets of 9 in. stoneware pipes, laid under the seats, and communicating directly with the external air, the inlets to the same being regulated with revolving slides.

The smoke-flue from the stove is of brickwork, covered with stone and concrete, and is laid in an opposite direction to the air-flues; this flue also passes under the seats for a distance of 12 ft.; when, through the external wall of the church, the flue is carried to the top of the tower (50 ft. in height), with 8 in. cast-iron pipes, which, being painted stone colour, are scarcely noticeable. After the apparatus has been lighted for a short time (the greater portion of the fuel used being coke) the smoke emitted from the flue is very little and hardly perceptible. At the bottom of the iron-pipe flue a damper is placed, by which, to a great extent, the heat of the building can be regulated.

Over the top of the feeding-chamber are inserted two cast-iron entrance flaps, with chequered surfaces, and over the air-chamber are fixed two iron gratings, through which the heated air is circulated into the building; at the same time, the apparatus draws out the cold air by means of two smaller gratings.

The spaces between the gratings and flaps are covered with brick arches on ⊥-iron girders, and the stone paving is relaid over the same.

The only indication that the apparatus is inside the building is the flap and gratings, over part of which the congregation have to walk, but not the slightest inconvenience is experienced from them.

The apparatus is very simple, the heated air not the least obnoxious, and the whole system gives entire satisfaction to all concerned.

ASSOC.-M.I.C.E.

Southampton, Nov. 20, 1888.

*** In reference to a previous letter on this subject, Messrs. A. M. Perkins & Son write to say that the system of small-bore pipes described as "Bacon's patent" was, in fact, the patent of A. M. Perkins, and is now the property of their firm and carried out by them.

ST. HILDA'S CHURCH, SUNDERLAND.

DEAR SIR,—"A Competitor," who writes you on the above subject, and whose letter appears in the last issue of your paper, is evidently a very superficial reader of the professional journals, for if he will refer to the issue of the *Builder* of Oct. 19, he will find the result of the above competition therein declared.

ANOTHER COMPETITOR.

COMPETITION FOR HOTEL AT DOUGLAS.

SIR,—In the *Builder* for Nov. 26, 1887, an advertisement appeared asking designs in competition for an hotel and boarding-house at Douglas (Isle of Man), and offering 25*l.* premium for the best design. This was issued by a Mr. Louis Kelly, a builder, of Douglas. In the particulars issued to intending competitors, it was stated that a professional assessor would be appointed.

I sent in a design in December, 1887, and not hearing anything concerning the matter, recently sent a request to Mr. Kelly for copy of the assessor's award, and return of my sketches if they were unsuitable. This has elicited no reply. Do any of your correspondents know anything of the business?

G. J.

THE MANCHESTER ARCHITECTURAL ASSOCIATION.

SIR,—Allow me to correct the report of my address in your issue of the 10th inst. (p. 345). The total number of practising architects in Manchester, of whom in July last only forty-seven had signed the form sent out by the Competitions Committee of the R.I.B.A., was by a clerical error stated as 118. It should be 168,—that is, two out of every seven. I may add that out of thirty-seven members of the Institute who should give special support to its efforts to improve the status of the profession, only nineteen had signed at that date.

A. H. DAVIES COLLEY, A.R.I.B.A.
48, *King-street, Manchester*, Nov. 21, 1888.

Registration of Plumbers. — A large public meeting of plumbers, architects, and others has been held in the Technical School, Belfast. The chairman, Mr. J. Mackenzie, said that sanitary plumbing was now regarded as one of the principal branches of technical education; and it was especially important that in a city like Belfast, with a population of 250,000, intelligent interest should be taken in the subject. Mr. F. W. Smith mentioned the steps which had been taken to form a class for the technical instruction of plumbers in co-operation with the Worshipful Company of Plumbers, London. The following, among other resolutions, was unanimously passed:—"That it is desirable steps should be taken to form a local council to co-operate with the Worshipful Company of Plumbers in support of the system of registration, as laid down in the rules of that guild." The operative plumbers at Dublin and district have also passed a resolution approving the Company's system, and a district council has been formed in that city. Ex-Provost Moncur presided at a meeting held a day or two ago at the Technical Institute, Dundee, on the occasion of the opening of Plumbers' classes there. At the monthly meeting of the Registration Committee at the Guildhall, about 750 fresh applications for registration were reported; 200 being from master plumbers and 550 from operatives. About 600 of the applications were received from the district councils acting in conjunction with the Plumbers' Company in the provinces.

The Student's Column.

ARTIFICIAL STONES.—XXI.

Treatment of Natural Stone Blocks, &c.

IN this division of the subject are grouped those devices which involve the treatment of certain natural stones, previously cut to desired shapes, so as to produce an appearance more or less resembling some more ornamental, costly, or durable stone. Several of the processes mentioned in Section 3 may also be included in this class, notably the process of Heinemann (1883, pat. 3,614), whose artificial marble is formed from gypsum, the articles cut from this stone being dried at about 212° Fahr. and then dipped in chloride of calcium solution, and then into one of hot concentrated sulphate of magnesium; the pores of the stone are thus filled with insoluble sulphate of lime and very soluble chloride of magnesium,—this latter salt must be got rid of by soaking in water; finally, the articles may be finished off with alternate applications of gelatine and of tannin.

St. Clair Massiah's patent (1850, pat. 13,218) was one of the earliest for producing on gypsum or alabaster articles an appearance resembling marble. The cut or sculptured articles were first dried at a temperature at from 80° to 150° Fahr., and then immersed in a warm solution of borax with a little *sal enixum*,* after removal and careful drying. They are subsequently heated up to 250° Fahr., and allowed to cool until the hand can just be borne on their surfaces, and then immersed for a second time in a solution of hot saturated borax, to which a little strong nitric acid has been added (½ oz. to 1 oz. of acid to every gallon of solution). The articles are now left to simmer until thoroughly saturated, and on drying will be found to possess a marble-like appearance. A day or two after they should be warmed again, and finished by rubbing over their surfaces a solution of Canada balsam in turpentine.

Fioravanti's patent (1863, pat. 970) also relates to the conversion of "gypseous lime-stone" into a marble-like material. The carved articles are first heated up to 250° Fahr., and then carefully cooled and placed in a bath of mineral solution, which may be composed of a great variety of ingredients, such as lime-water, sulphate of iron, cyanides, aluminates, or caustic soda or potash. If it is desired to colour the articles, they should be treated alternately with salts that, reacting on each other, will produce the desired tint; thus for blue, the stone should be first steeped in a solution of prussiate of potash, and subsequently in one of an iron salt.

M. Soderini, of Florence, secured three patents in 1884 (Nos. 2,640, 2,787, and 2,847) for the treatment of gypsum, selenite, or other natural sulphate of lime. In patent 2,640 the stone is first deprived of water by heating, and then immersed in boiling aqueous solutions or mixtures of silicate of lime, sulpho-silicate of potash, acid fluosilicate of potash, double silicate of potash, and manganese, &c. Chloride of lime, sulphate of potash, phosphate of lime, soda and potash, and borax, are a few of the other substances mentioned as applicable. The material, after soaking in the selected bath, is again thoroughly dried, and again immersed, and re-dried, these operations being repeated as often as may be found necessary. The patent also provides for the colouring of marbles. The second patent (No. 2,787) relates to the treatment of sculptured articles in alabaster, which are to be hardened, and converted into artificial marble by being heated from 37·5° to 50° C., and then immersed in a solution of 8 parts of borax and 1-50th part of potassium biphosphate, in 100 parts of water, at a temperature of 22·5° C. After impregnation with this solution, the articles are dried at a temperature not exceeding 150° C. When cooled, they are immersed in a solution of borax, to which has been added nitric acid, in the proportion of from 30 to 50 per cent. of the water of the solution. The process may be modified by substituting oxalic for nitric acid, and by finishing the objects with a solution of Canada balsam in naphtha. Soderini's third patent was for the production of a black marble-like stone from any natural gypsum, by heating the shaped articles in a hot preparation of bitumen of suitable strength; the water is expelled, and

* An obsolete term applied to the residue (composed of acid sulphate of potassium) left in the preparation of nitric acid from nitre and sulphuric acid.

the bitumen takes its place, filling the pores, and producing a compact mass of a brilliant black colour, and considerable hardness.

In Robbin's patent (1884, pat. 12,803) the blocks of gypsum are first dried and then charged or otherwise treated with tar, pitch, alkaline silicate, or chloride of aluminium, &c. The articles are then cut to the desired shape and indurated or finished by exposure to sulphurous vapours, and application of paraffin, gums, resins, &c. For the conversion of the soft natural carbonate of lime, known as chalk, into a harder and more useful stone, several attempts have been made; one of the earliest being in 1841, which involved the injection of the chalk with silicates of soda or potash, or with melted sulphur or bituminous, fatty, or resinous substances.

Darvill obtained in 1862 provisional protection only, for a process which aimed at the hardening of chalk by first drying and then immersing it in solutions of alkaline silicates or tungstates followed by one of chloride of calcium.

Miss H. G. Hosmer patented in 1877 the following process for the production of a marble like surface on ordinary limestone. The stone having been cut to desired shape is heated in a boiler with water under a pressure of several atmospheres for twelve or eighteen hours; it is then removed to another bath consisting of alum and water, in which it must remain for at least twenty-four hours, or even so long as a month: this treatment does not materially alter the colour of the stone, but renders it capable of a high polish. If a coloured marble be desired, the requisite dyes and pigments must be added to the alum bath.

Sandstone has also been "marbleised," as it is termed, by impregnation first with a solution of sulphate of alumina and then with one of water-glass; it is thus made to assume a somewhat marble-like appearance, and rendered capable of being polished. By heating the impregnated sandstone strongly, partial vitrifaction results, and with ornamental effect if suitable colours have been previously added to the impregnating materials.

RECENT PATENTS.

ABSTRACTS OF SPECIFICATIONS.

16,621, Moulding, Pressing, and Drying Tiles. J. Larmanjat.

The tiles which are made according to this invention are made of hydraulic lime, cement, &c., and of relatively large size, and in different colours, so as to produce the representation of a leaf, for example, having the veins, half tints, and a well-defined outline. The construction of the moulds and presses are simplified, and an improved method of drying is adopted. The inlaid patterns are formed by removable pattern blocks being used with the mould, and when made the tiles are specially protected whilst drying, in order to fully preserve the patterns on the face.

17,285, Cure for Smoky Chimneys. H. A. Hancock.

This invention relates to the employment of one or a series of fall-down or sliding leaves or plates to work in notched or recessed rebated side frames. The leaves are attachable to an open or domestic stove or fireplace, so that the leaf, or any number of them, can be lowered and be fixed in a position to induce up-draught in the chimney, and prevent down-draught.

17,993, Chimney and Ventilating Cowls. J. Winterflood.

It is claimed that the cowl which is the subject of this invention will, by its revolving action, produce an up-current of air, and the shape will at the same time prevent rain beating down,—a frequent cause of down-draughts. On a rim a number of vanes or fans of a treble curved form are fixed. Single curved vanes are fixed on cover surmounting the top rim. The cowl is carried by an iron bracket or crossbar fixed in the tube, and suitable arrangements are made for oiling the spindle and bearing.

9,556, Faïence, or Glazed Terra-Cotta Mantels, &c. J. Holroyd.

The idea of this invention is to manufacture Faïence mantel-pieces and firesides, and such like articles, in such form that they may be readily put together and fixed where required, and can be removed without injury. The pieces are joined and adjusted in a "float," and are made into one length or block of material.

12,758, Circular Saws. G. Montague.

The cutting edge of the teeth of the saw which is the subject of this patent is set in advance by bevelling the front edge of the tooth. The object is to produce a saw having teeth of such a character that will be strong and durable, and will work with equal facility crosswise or lengthwise of the grain.

13,444, White Lead. N. K. Morris.

The chief improvement in the manufacture of white lead, according to this invention, is the acetic acid being maintained in the form of vapour, and the gas and vapour is forced into the corroding chambers by suitable pumps.

NEW APPLICATIONS FOR PATENTS.

Nov. 9.—16,219, W. Press, Cistern Valves.—16,234, J. James, Calcining Cement Materials, &c.—16,262, P. Neate, Portland Cement.—16,272, B. Holbrook, Ventilators.

Nov. 10.—16,285. J. Nicholls, Window-sash Holder and Bolt.—16,323, A. Bouvier and J. Bilorè, Bricks, Tiles, &c.

Nov. 12.—16,354, R. Taylor, Mixing Machine for Concrete, &c.

Nov. 13.—16,408, J. Sharples, Flushing the Pans of Water Closets.—16,410, F. Stokes, Furnaces for Burning, Calcining Cement, Lime, &c.—16,448, T. Smith, Mitreing Machines.

Nov. 15.—16,574, St. J. Day, Ventilators.—16,620, A. Hopton, Windows.

PROVISIONAL SPECIFICATIONS ACCEPTED.

8,004, D. Gill, Windguards for Shafts and Chimneys.—14,179, J. Killey, Inspecting the Interiors of Pipe Sewers, &c.—14,364, F. Rogers, Fastenings for Doors, Windows, &c.—14,681, J. Tollerton, Fireproof Curtains for Theatres, &c.—14,724, L. Wilson, Parquetry, &c.—14,853, G. Pankhurst, Brick, Tile, or Slab.—14,970, F. Praill, Combination Inglenook.—15,176, L. Teale, Fireplaces.—15,379, J. Hargreaves and A. Armitage, Fire-grates.—15,531. J. & A. Duckett, Water-closets.—15,576, P. Walker, Ventilating Rooms.

COMPLETE SPECIFICATIONS ACCEPTED.

Open to Opposition for Two Months.

15,306, J. Panweis, Water-meters.—494, J. Hilton, Fireproofing Buildings.—521, W Wade, Doors and Panelled Structures.—578, F. Moore, Speaking-tubes.—605, K. Brunnschweiler, Fire-grates.—673, E. McClellan, Inlets for Sewers, Traps, and Drains.—2,731, W. Graham, Wood-cutting Bow-saw.—4,012, T. Dykes, Sash-fasteners.—4,170, A. Sizer, Slow-combustion Kitchener.—4,493, J. and A. Sizer, Chimney-cowls and Ventilators.—13,666, E. Mertz, Moistening and Cooling Air in Buildings, &c.—14,750, C. Waxin and A. Clery, Cement or Artificial Stone.

RECENT SALES OF PROPERTY.

ESTATE EXCHANGE REPORT.

Nov. 12.

By W. Hall.

Notting-hill—126, High-street, 26 years, ground-rent £55	£720
124a, High-street, 26 years, ground-rent £7	250
122, High-street, 26 years, ground-rent £40	410
North Woolwich—Ground rent of £20, reversion in 90 years	400
Fulham—2, Oxberry-avenue, 97 years, ground-rent £8	370
52, Waldemar-avenue, 97 years, ground-rent £7	400
32, Fulham Palace-road, 97 years, ground-rent £7. 10s.	330

By Slade & Butler.

Wood-green, Whittington-road—"Castlenau," 90, years, ground-rent £7. 7s.	235
Islington—73, Essex-road, Copyhold	900
Clerkenwell—2 to 6, River-street, 24 years, ground-rent £23. 11s.	1,485
25, River-street, an income of £4 a year for 24 years	42

Nov. 13.

By C. P. Whiteley.

New Southgate—9, Southgate Villas, 64 years, ground-rent £5. 10s.	400

By Pinder, Simpson, & Newman.

City, Prujean-square—Ground-rent of £800, reversion in 80 years	17,500

By Dent & Dallas.

Fulham, Sherbrooke-street—The South Kensington Laundry, 88 years, ground-rent £21	1,250

Nov. 14.

By Boyton & Pegram.

Fulham—19, Hilton-terrace, 93 years, ground-rent £15	850

By C. & H. White.

Putney—24, 26, and 28, High-street, freehold	3,510
Weimar-street—Six plots of land, area 5,260 ft., term 80 years, let at £31. 19s. 6d.	
High-street—A plot of land, 1,710 ft., let at £22. 10s.	
Battersea Park-road—Nos. 286, 292, and 294, term 89 years, ground-rent £32. 10s.	2,400

By Protheroe & Morris.

Forest Gate—1 to 19, Travellers' Cottages, 79 years, ground-rent £57	1,720

Nov. 15.

By Bray, Young, & Co.

Oxford-street—48, James-street, freehold	1,640

By Newbon & Harding.

Highbury—23, Riversdale-road, 82 years, ground-rent £7	300
Holloway—11, Bedford-terrace, 77 years, ground-rent £6	205
9, 11, and 13, Raydon-street, 91 years, ground-rent £15. 15s.	455
Hackney—157, 159, and 161, Great Cambridge-street, 26 years, ground-rent £24	460
Camden Town—214, Camden-road, and stabling, 50 years, ground-rent £7. 10s.	1,100
Kentish Town—An improved rental of £60, term 11 years	140
Mecklenburgh-square—57, Doughty-street, and workshop, term 13 years	200
Fulham—Ground-rents of £59. 10s., reversion in 74 years	1,490
Leytonstone, Hainault-road—"Beech Villas," freehold	460
Thorne Villa, freehold	450
8 and 9, Primrose-terrace, freehold	490
6, Barnet-terrace, freehold	245

By Bradel & Co. (At Brighton.)

Preston, Home-road—Three plots of freehold land	960
North-road—Preston Cottage, freehold	620
Three plots of freehold land	760
Middle-road—Two plots of freehold land	850
Ten freehold cottages	1,130
Preston-road—Acacia House, and the Brewery Tap, freehold	4,000

Nov. 16.

By Dolman & Pearce.

Regent's Park—22, St. Mark's-crescent, freehold	840
Primrose Hill—4, Oppidan's-road, 76 years, ground-rent £12	605

Nov. 16.

By Norton, Trist, & Gilbert.

Fleet-street, No. 16—The lease and goodwill, "Groom's Coffee House," term 27 years, ground-rent £55. 10s.	5,850
Upper Norwood—49, Belvedere-road, freehold	750
Hammersmith, Yeldham-road—Ground rents of £92, reversion in 82 years, including mortgage	2,035
Biscay-road—Ground rents of £99, reversion in 82 years, including mortgage	2,060

MEETINGS.

Monday, November 26.

Society of Arts (Cantor Lectures).—Captain W. de W. Abney, F.R.S., on "Light and Colour." 8 p.m.

Liverpool Architectural Society.—Sir James A. Picton, F.S.A., on "Notes on the Successive Town Halls of Liverpool." 7 p.m.

Leeds and Yorkshire Architectural Society.—Mr. A. Marshall, on "Furniture and Woodwork of the Seventeenth Century." 7.30 p.m.

Tuesday, November 27.

Institution of Civil Engineers.—Mr. J. E. Williams on "The Witham New Outfall Channel and Improvement Works." 8 p.m.

Wednesday, November 28.

Society of Arts.—Col. Gouraud on "The Phonograph." 8 p.m.

St. Paul's Ecclesiological Society.—Mr. J. Grimshire, on "A Short Account of the Ancient Cathedrals and Conventual Churches of Scotland." 7.30 p.m.

Thursday, November 29.

Builders' Benevolent Institution.—Annual Dinner. 6 p.m.

Society of Antiquaries.—8.30 p.m.

Arts and Crafts Exhibition Society.—Paper on "Design," and Presidential Address, by Mr. Walter Crane. 8.30 p.m.

Edinburgh Architectural Association.—Mr. D. MacGibbon on "The Castles of the Western Highlands and Islands of Scotland." 8 p.m.

Friday, November 30.

Institution of Civil Engineers (Students' Meeting).—(1) Mr. E. T. Hildred on "The Covered Service-Reservoir of the Southampton Corporation." (2) Mr. H. Ashley on "The New High-level Storage-reservoir for the Grand Junction Waterworks Company at Hanger Hill, Ealing." 7.30 p.m.

Saturday, December 1.

Association of Public Sanitary Inspectors.—Mr. D. Richards on "A Few Characteristics of the Three Principal Animals used for Human Food." 6 p.m.

Miscellanea.

Liverpool Engineering Society.—A meeting of the Liverpool Engineering Society was held on the 14th inst., Mr. Charles H. Darbishire, Assoc.M.Inst.C.E., President, in the chair, when a paper was read by Mr. T. Mellard Reade, C.E., F.G.S., on "The advantages to the Civil Engineer of a study of Geology." Mr. Reade, speaking of reservoirs, said that owing to a faulty idea of the geological surroundings of sites for such purposes, disastrous mistakes might easily be made, and he mentioned a case in which a local board incurred double expense owing to a reservoir being placed in an injudicious position, the water permeating its bed and sides, which might have been avoided had the engineer been in possession of better information on the particular branch of science to which he referred. The author spoke of subsidence which took place recently during the progress of the Mersey Tunnel works, he having indicated that the excavations would have to be carried on at a lower point than was primarily intended, in consequence of a channel filled with drift which lay below the level of the bed. This was eventually verified, resulting in the works being sunk to a lower level and the difficulty overcome. In the course of discussion the geological formation of the Vyrnwy Lake, Panama Canal, &c., &c., were entered into.

Jerry-building in Moscow.—Unfortunately the recent case of jerry-building in Moscow, whereby a house fell whilst in the course of construction, and which we quoted from the *Daily Chronicle*, was after all attended by great loss of life and serious injuries,—no less, states the official report, than sixteen workmen being killed and twenty-four more or less injured. The building in question was the Commercial Club of Moscow.

New Mortuary for Marylebone.—This is situated at the south corner of York-court (now closed), facing the old St. Marylebone Burial Ground, approached by a private roadway from Paddington-street. The buildings are arranged in three distinct blocks, separated from one another by paved roadways. On the south side is the Public Mortuary, the internal walls of which are lined with light glazed tiling their whole height, the floor is tiled, and the windows filled with tinted glazed lights. The east end of this room is divided off by a pointed archway, and will be available for use as a mortuary chapel for conducting funeral services. On the north side are contained in one block a Post-mortem Room and Coffin Store, also an Inquest Mortuary, and separated from it by a large glazed partition, a lobby for the convenience of jurors viewing the bodies. The arrangements in these two departments are very similar (although not on so large a scale) to the Morgue in Paris. With the exception of the coffin store, these rooms are lined with high dadoes of white glazed bricks or tiles, and are amply lighted by windows and roof lanterns. The revolving post-mortem table has been specially designed for the building on improved principles. The architects are Messrs. H. Saxon Snell & Son, and the builders Messrs. Wall Bros., whose contract for the works amounted to 3,131*l.*, including the heating and gas fittings, carried out by Messrs. May Bros. The tiling was executed by Messrs. Simpson & Son.

Sales by Auction.—At the White Hart, Launceston, by auction, on November 24 current, the manor of Crackington St. Gennys, which embraces some two miles of the northern coast, by the lofty headlands of High Cliff, Dizard, and Cambeak, between Boscastle and Bude. This estate, of over 1,510 acres, nearly all being under cultivation, contains a plantation, several farms, cottages, &c., and an inn. The ancient stone church of St. Genesius was restored in 1871, at a cost of nearly 1,200*l.*, by Mr. J. St. Aubyn. An extension of the railway to Camelford, in the immediate neighbourhood, is contemplated.—On the 8th of December, by auction, at the Bell Hotel, Gloucester, the Churchdown Estate, consisting of the three farms, Parton Court, Upper Parton, and the moated Elm Bridge Court, lying along the high-road from Gloucester to Cheltenham. The property covers 789 acres of land—arable, pasture, and orchard—ring-fenced, and situated in Hucclecote (ecclesiastical) and Churchdown parishes, being distant about two miles from the Cathedral city.

The Late Irish Exhibition—The Women's Art and Industries Section of this exhibition, under the presidency of the Countess of Aberdeen and a Committee of Ladies, has, according to the report, proved the most successful, as it has certainly been one of the most useful, departments of the exhibition. It was organised and managed by Mr. J. S. Wood, on behalf of Lord Arthur Hill, the honorary secretary, and, together with the Fancy Fair in July, realised a sum of nearly 3,000*l.* for the Executive Council of the exhibition. In addition to this, articles made by peasants in Ireland have been sold to the extent of 1,200*l.*, the greater part of which sum has found its way into schools and cottages throughout Ireland, either direct or through such societies as the Irish Home Industries Association. It is announced that Lady Aberdeen has arranged to continue the sale of the work of poor Irish peasants in the Old Irish Market Place during the Winter Exhibition at Olympia.

The Royal Female School of Art.—We are asked by Miss Louisa Gann, the Superintendent of this school, to announce that H.R.H. the Princess Christian will open, on Friday, December 7, the new studio for the study of the life, and the library, lecture, and class rooms, which have been added to the Royal Female School of Art, Queen-square, under the superintendence of Mr. Ernest Turner, Architect.

Purbeck Stone.—A correspondent, writing from Swanage, says that the figures referred to in our article of last issue, as being very badly weathered, are of Portland, and not of Purbeck, and were brought from another situation. They were too high up to be well seen, and we concluded they were the local stone.

Great Tower-street.—Messrs. Ashby Bros., Old Broad-street, E.C., are the contractors for rebuilding 2, Great Tower-street, for Messrs. Dore & Sons. Messrs. Young, Son, & Johnson are the architects.

Progress in Japan.—The land of the Mikado is advancing rapidly along the lines of European civilisation. From a number of statistics just published in the current issue of the *Board of Trade Journal*, we gather the following notes:—The number of post-offices existing in Japan in 1885 was 4,137; number of letters transmitted, 97,216,019; of newspapers, 15,258,671; of books and samples, 2,594,156. In the same year there were 886 money-order offices in operation, from which 833,300 orders were issued, and 826,626 paid. The number of telegraph offices in 1885–86 was 280; there were 5,779 miles of telegraph lines; the number of telegrams sent was 1,790,282; of telegrams received, 1,789,522. The mileage of railways in the same period was 410; number of railway-stations, 93; of locomotives, 76. The number of passengers carried was 4,067,970. The number of post-office savings-banks at the end of 1885 was 4,338; of commercial banks, 141, having 122 branch establishments. The average rate of wages paid to the working classes in Japan are:—Carpenters, 1s. 1d. per day; plasterers, 1s. 2d. per day; stone-cutters, 1s. 2d.; sawyers, 1s. 1d.; slaters, 1s. 3d.; paper-hangers, 1s. 2d.; joiners, 1s. 1d.; tailors (Japanese fashion), 1s.; ditto (European fashion), 1s. 7d.; dyers, 10d.; smiths, 1s. 1d.; printers, 10d.; compositors, 1s. 1d.; agricultural labourers, 9d.; day labourers, 10d.

A Novel Fireproof Curtain for Theatres.—The chief of the Fire Brigade in the city of Malmö, in Sweden, Herr O. Berggren, has constructed a fireproof curtain for a theatre, which he calls a "water curtain." It consists of two sheets of canvas, steeped in a fireproof compound, joined together at the bottom and the sides in such a manner as to leave a fair space between, with water-mains running to the top, and when fire breaks out, and the water being turned on, the intervening space becomes filled with water, forming a solid wall of water between the audience and the scene. The other day experiments were carried out with the curtain in an improvised structure in Malinö, in presence of the officials of the town, architects, and others, when a pile of faggot-wood was heaped up against the curtain and set fire to, but the flames made no impression on it, even when petroleum was poured upon the fire. It is claimed by the constructor that the water-curtain is particularly suited for old theatres, whose construction will not sustain the weight of iron curtains; moreover, that the former do not get "jammed," which is so often the case with the latter, generally in the hour of need.

The "Remington Standard Type-Writer."—On Saturday, the 17th inst., we witnessed at Anderton's Hotel, Fleet-street, some demonstrations of the speed and other capabilities of this now well-known type-writer, of which a new and greatly-improved form, called the "No. 5," has just been introduced. With a little practice we believe it to be quite possible to "write" with this machine as quickly as with the pen, and even more quickly. One of our reporters has used the "Remington" for several years, and his testimony is to this effect. The more general employment of the type-writer by contributors, reporters, and correspondents would be a great boon to printers, and the innumerable errors arising from semi-illegible manuscript would no longer vex the souls of editors and readers. The type-writer has evidently passed out of the condition of a mere scientific toy, and has acquired for itself a position of great practical utility. We believe that it has a great future before it.

Royal Institution.—The next course of Christmas lectures adapted to a juvenile auditory will be given by Professor Dewar, F.R.S., the subject being "Clouds and Cloudland." They will begin on December 27. During the recess, the staircases leading from the gallery of the theatre have been considerably altered, in order to facilitate more speedy egress.

The Sanitary Institute.—At a meeting of the Council of this Institute held on the 4th inst., Sir Douglas Galton, F.R.S., in the chair, Earl Fortescue, Dr. B. W. Richardson, F.R.S., Sir T. Spencer Wells, and eleven other Members and Associates, were enrolled, and further applications for membership were read.

Peterborough Cathedral.—A correspondent informs us that one of the pinnacles belonging to the north-west tower of the west front of Peterborough Cathedral fell on Tuesday afternoon during a sudden gust of wind. It dropped into an enclosed space and almost buried itself in the soil.

The Effect of Moisture on Wood.—Dr. Hildebrand has carried on investigations into the action of moisture upon various kinds of wood, the results of which he publishes in *Wildemann's Annalen der Physik und Chemie*. We learn from the article on the subject, which is a lengthy one, that the author confined himself in his experiments to observing the extension of the longitudinal fibres of wood, leaving out of consideration the well-known phenomena of the swelling and the shrinkage of wood, which take place in a direction perpendicular to the longitudinal fibre. The author finds that, within certain limits, the length of wood in the direction of its fibre depends upon the amount of water present in its membranous tubes. Supposing a wood absorbs from 20 to 30 per cent. of water (which is the range of the increase of weight dried under an air-pump), the increase of length varies between 0·1 and 2 per cent. The greatest length is attained when wood is kept in air saturated with steam, or when placed in water. The weight and length of wood increase with the relative moisture of the air, and diminish with the decrease of moisture. The kinds of wood named below, which were exposed to the natural variations of moisture in the air during summer, showed the following changes:—

	Relative Moisture of the Air.		Variation in Length. Per cent.
Mahogany	0·814 / 0·570	.....	0·057
Ebony	0·814 / 0·665	.....	0·03
Fir	0·798 / 0·765	.....	0·012
White Beech	0·814 / 0·570	.....	0·05
Red Beech	0·814 / 0·570	.....	0·043
Alder	0·814 / 0·665	.....	0·047
Oak	0·798 / 0·584	.....	0·062
Lime-tree wood	0·798 / 0·584	.....	0·028
Maple	0·814 / 0·665	.....	0·019
Pine	0·798 / 0·570	.....	0·043
Poplar	0·814 / 0·570	.....	0·069

The author says that great care should be exercised in selecting wood for measuring-rules. Mahogany and oak are entirely unsuited for rules, and the best woods to be used for the purpose are maple, fir, red beech, and lime-tree. He also states that the usual treatment of wood with polish, oil, or lacquer does not protect wood from the action of air saturated with steam. The best protection is afforded by lacquering, but the lac employed should be most carefully selected if the wood is intended for rules to be used for exact measurement. The author further adds that even ivory is not free from the action of moisture.

The People's Palace Technical Schools, Mile End-road, E.—With the view of spreading an interest in the question of technical education, and also for the purpose of demonstrating what such education means, the Trustees of the People's Palace have decided to organise two conversaziones to be held on the evenings of Saturday, November 24, and Saturday, December 1. The programmes will include (besides gymnastic displays in the gymnasium and a concert in the Queen's Hall) an exhibition in the New Technical Schools, recently built by the Drapers' Company. All the different departments of the Schools will be open for inspection, and the boys of the Technical Day School will be seen at work at the bench, vice, lathe, &c. Experiments will be performed by the boys in the chemical and electrical laboratories. Boys will be seen at work on various kinds of drawing, also at wood-carving, modelling, &c.

Destruction of an Ancient Norwegian Church by Fire.—The Nœs Church, by the Lake Mjösen, in Norway, so well known to tourists through its picturesque situation, was totally destroyed by fire the other day. It dated from the early part of the thirteenth century. The fire was caused by the carelessness of workmen.

Langley (Bucks).—The committee of the Langley New Town Mission Church having instructed their architect, Mr. Albert E. Pridmore, of London, to prepare the necessary plans, &c., that gentleman has forwarded two separate schemes, which will be considered at the next meeting.

The English Iron Trade.—The English iron market is quieter, and weaker in some branches. Pig-iron is less steady, although quotations do not show much change. There is less pressure to do business both on the part of buyers and sellers. Scotch warrants have declined during the week. North of England iron can be obtained at 33s. 6d., but makers quote 34s. There is no change in pig-iron in Lancashire and Staffordshire, where prices are well-maintained. Hematite has experienced a fall, chiefly due to operations in warrants, and the quotation with makers for mixed numbers of Bessemer iron is 44s. 3d. Manufactured iron, with the exception of sheets, is not so strong as it was, and new orders might be placed a shade under recent quotations in the North of England and Scotland; elsewhere there is rather a stiffening tendency. There is a better inquiry for tin-plates, and quotations are unchanged. Steel is very well maintained, there being still a very good call for it, excepting for rails in the North, where the demand has quietened down. The shipbuilding trade is as active as ever, and engineers continue well supplied with work.—*Iron.*

The New Fountain in Front of the Royal Palace in Berlin.—The new fountain to be erected in front of the Royal Palace in Berlin, at the cost of the city, in commemoration of the present Emperor of Germany's foreign journeys, has already been finished by Professor Vegas, and is declared by German art critics to be the finest production of this well-known sculptor. It is now exhibited in the Berlin National Gallery, and consists of a marble basin of great size, on the brim of which the four main rivers of Germany are represented by four colossal female figures. From the centre of the basin rises a pile of heaped-up rocks, on the summit of which Neptune is seated, whilst the lower part is adorned with allegorical titans, marine monsters, &c., all of whom eject water columns in a manner arranged with the greatest harmony. The whole is about 25 ft. in height.

PRICES CURRENT OF MATERIALS.

TIMBER.	£.	s.	d.	£.	s.	d.
Greenheart, B.G.....ton	6	10	0	7	10	0
Teak, E.I.....load	9	0	0	14	0	0
Sequoia, U.S.....foot cube	0	2	3	0	3	0
Ash, Canada.....load	3	10	0	5	0	0
Birch ,, ...load	3	10	0	6	0	0
Elm ,, ...load	4	0	0	5	0	0
Fir, Dantsic, &c. .....load	2	0	0	4	0	0
Oak ,, ...load	2	0	0	4	10	0
Canada .....load	5	10	0	7	0	0
Pine, Canada red .....load	3	5	0	4	0	0
,, yellow .....load	3	10	0	5	10	0
Lath, Dantsic.....fathom	4	10	0	5	10	0
St. Petersburg.....load	5	0	0	6	10	0
Wainscot, Riga, &c.....log	2	15	0	4	5	0
,, Odessa, crown.....log	2	15	0	3	5	0
Deals, Finland, 2nd and 1st...std.100	10	0	0	10	10	0
,, ,, 4th and 3rd.....std.100	7	0	0	9	10	0
Riga std.100	7	0	0	8	0	0
St. Petersburg, 1st yellow std.100	10	10	0	15	10	0
,, 2nd ,, ...std.100	9	0	0	10	0	0
,, white std.100	8	0	0	10	10	0
Swedish.....std.100	8	0	0	16	10	0
White Sea std.100	9	0	0	17	10	0
Canada, Pine, 1st .....load	16	0	0	25	10	0
,, ,, 2nd .....load	11	0	0	17	10	0
,, ,, 3rd, &c. .....load	7	10	0	10	10	0
,, Spruce, 1st .....load	9	0	0	10	0	0
,, ,, 3rd and 2nd .....load	7	0	0	8	10	0
New Brunswick, &c. .....load	6	15	0	8	15	0
Battens, all kinds .....load	5	10	0	12	0	0
Flooring Boards, sq., 1 in., prepared, First .....foot	0	11	0	0	14	6
Second .....foot	0	8	0	0	10	9
Other qualities .....foot	0	5	6	0	7	9
Cedar, Cuba.....foot	0	0	3½	0	0	3¾
Honduras, &c.....foot	0	0	3¼	0	0	3¾
Australian .....foot	0	0	2¾	0	0	3
Mahogany, Cuba .....foot	0	0	4½	0	0	5½
St. Domingo, cargo average .....foot	0	0	4½	0	0	5½
Mexican ,, ...foot	0	0	4½	0	0	4¾
Tobasco ,, ...foot	0	0	4½	0	0	5¾
Honduras ,, ...foot	0	0	4½	0	0	5½
Box, Turkey .....ton	5	0	0	12	0	0
Walnut, Italian .....foot	0	0	4½	0	0	6½

METALS.	£.	s.	d.	£.	s.	d.
IRON—Bar, Welsh, in London...ton	4	17	6	5	0	0
,, ,, at works in Wales ...	4	7	6	4	10	0
,, Staffordshire, in London ...	5	15	0	7	0	0
COPPER—						
British, cake and ingot..... ton	81	0	0	82	0	0
Best selected .....ton	82	0	0	83	0	0
Sheets, strong .....ton	86	0	0	88	0	0
Chili, bars .....ton	78	0	0	78	10	0
YELLOW METAL.....lb.	0	0	7½	0	0	7½
LEAD—						
Pig, Spanish .....ton	13	2	6	0	0	0
English, common brands .....ton	13	10	0	0	0	0
Sheet, English.....ton	14	7	6	0	0	0
SPELTER—						
Silesian, special .....ton	18	10	0	18	12	6
Ordinary brands.....ton	18	7	6	18	10	0
TIN—						
Banca .....ton	103	0	0	0	0	0
Billiton.....ton	102	0	0	0	0	0
Straits .....ton	101	10	0	0	0	0
Australian .....ton	101	10	0	0	0	0
English Ingots.....ton	104	0	0	0	0	0
ZINC—English sheet .....ton	22	10	0	23	10	0

OILS.	£.	s.	d.	£.	s.	d.
Linseed .....ton	19	7	6	19	10	0
Cocoanut, Cochin .....ton	27	0	0	28	0	0
Ceylon .....ton	26	0	0	0	0	0
Palm, Lagos .....ton	27	10	0	0	0	0
Rapeseed, English pale .....ton	30	15	0	31	0	0
,, brown .....ton	29	5	0	29	10	0
Cottonseed, refined .....ton	23	15	0	0	0	0

OILS (*continued*).	£.	s.	d.	£.	s.	d.
Tallow and Oleine .....ton	19	0	0	45	0	0
Lubricating, U.S. .....ton	5	0	0	6	0	0
,, refined .....ton	7	0	0	12	0	0
TURPENTINE—						
American, in casks.....cwt.	1	15	3	0	0	0
TAR—Stockholm .....barrel	1	1	6	0	0	0
Archangel .....barrel	0	13	0	0	0	0

COMPETITIONS, CONTRACTS, & PUBLIC APPOINTMENTS.

Epitome of Advertisements in this Number.

COMPETITIONS.

Nature of Work.	By whom required.	Premium.	Designs to be delivered.	Page.
Approach to Assembly Rooms	Chelsea Hotel and Club Association, Lim.	15 Guineas	Dec. 3rd	ii.
Alteration to Institute Building, Faversham	The Committee	10 Guineas	Not stated	ii.

CONTRACTS.

Nature of Work, or Materials.	By whom required.	Architect, Surveyor, or Engineer.	Tenders to be delivered.	Page.
Dust Cart	Lewisham Bd. of Wks.	*Official*	Nov. 27th	ii.
Guernsey Granite Spalls	do.	do.	do.	ii.
Building Married Quarters, Aldershot	War Department	do.	Nov. 28th	ii.
Broken Kentish Ragstone	Hendon Local Board	S. S. Grimley	Dec. 3rd	ix.
Deepening Well	Cromer Waterworks Co.	J. C. Melliss	Dec. 4th	ii.
Waterworks	Sutton in Ashfield L.B.	G. Hodson	do.	ii.
Iron Posts and Railings	Brentford Local Board	*Official*	do.	ix.
Kerbing, Pitching, and Patent Victoria Stone	Leyton Local Board	W. Dawson	do.	ix.
Water Mains, Hydrants, Sluices, &c.	Mansfield U.R.S.A.	G. Hodson	Dec. 5th	ii.
Arcade, with Shops, Cellars, &c.	Pontypridd Arcade and Building Co., Lim.	Taylor & Evans	do.	ii.
Annual Stores	G. N. R. Co.	*Official*	Dec. 8th	ii.
Pumping Engine and Boiler	West Ham Corporation	Lewis Angell	Dec. 11th	ii.
Kentish Rag Tar Paving	Barking Local Board	C. J. Dawson	Dec. 12th	ix.
Road-making Works	do.	do.	do.	ix.
School, Lewisham	Leathersellers' Company	E. L. Parsons	Dec. 25th	ix.
New Pelican Club	The Proprietors	Walter Emden	Not stated.	ix.
Barracks at Canterbury	Salvation Army	J. W. Dunford	do.	ix.
Hospital at Swansea	The Committee	J. B. Wilson	do.	ix.

PUBLIC APPOINTMENT.

Nature of Appointment.	By whom Advertised.	Salary.	Applications to be in.	Page.
Clerk of the Works	Camberwell Guardians	3*l.* 3s. per week	Nov. 28th	xiv.

TENDERS.

[Communications for insertion under this heading must reach us *not later than* 12 *Noon on Thursdays.*]

BERMONDSEY. — Reduced tenders for seven new shops and a stable, Bermondsey New-road, for Mr. J. E. Armfield. Mr Edward Crosse, architect, 32, Bermondsey-square, S.E. Quantities by Mr. Thomas J. Fife, 2, Whittington-avenue, E.C.:—

F. & H. F. Higgs	£3,000
W. Shepherd	2,972
T. Rider & Son	2,944
A. White & Co.	2,916
W. & F. Croaker (accepted)	2,852

BERMONDSEY.—For erection of workshops, Earl-road, for Mr. Doerr. Mr. Edwd. Crosse, architect, 32, Bermondsey-square, S.E. Quantities by Mr. Thos. J. Fife, 2, Whittington-avenue:—

Greenwood	£1,528
Down	1,496
Tarrant	1,490
Shepherd	1,483
Chalkley	1,469
A. White & Co.	1,469
Croaker	1,462
Spencer & Co.	1,460
Higgs	1,430
Holloway	1,383
Tyerman (accepted)	1,355

BOW.—For pulling down and re-erecting the "Five Bells," Old Ford-road, Bow, E., and the erection of two cottages adjoining, for Messrs. Charrington & Co. Mr. J. M. Knight, architect:—

J. & H. Cocks	£2,593
Bentley	2,555
Hunt	2,446
F. & J. Wood	2,424
Herle & Son	2,377
Gladding (accepted)	2,346
Hood	2,294

BRIGHTON.—For the construction on the Madeira-road of a terrace-walk, an enclosed shelter hall with rooms and lavatories attached thereto, a hydraulic lift, and other works in connexion therewith, for the Corporation of Brighton:—

G. G. Garbutt, Brighton	£21,538
W. J. Botterill, London	17,998
J. G. B. Marshall, Brighton	17,990
W. Hill & Co., London	17,100
J. T. Chappell, London and Brighton	16,444
W. H. Sayle, Worthing	16,355
A. Kellett, Ealing	15,770
W. W. Smith, Worthing	15,530
A. Dean, Brighton	15,500
Kirk & Randall, Woolwich	15,310
J. Harrison & Son, Brighton	15,250
Cheesman & Co., Brighton	15,081
C. G. Reed & Son, Brighton	15,050
G. E. Wallis & Sons, Maidstone	14,637
Perry & Co., Bow	13,990
Longley & Co., Crawley (accepted)	13,975
Deacon & Co., Lower Norwood	13,400

[A tender was also submitted to perform the works for £14,514, but no name was attached to it.]

BETHNAL GREEN.—For clean-linen room at laundry, covered ways and sanitary turret at the Workhouse. Messrs. A. & C. Harston, architects, 15, Leadenhall-street. Quantities supplied:—

Jackson & Todd	£1,579
E. Lake	1,398
H. Adams	1,383
Staines & Son	1,346
W. Johnson	1,290
J. Holland	1,278
Barrett & Power	1,276
C. J. Sherwood	1,248
R. Edwards, jun.	1,193
Aplin & Redgrove	1,191
Geo. Lusk	1,116
R. Cox	1,084
Jas. Edmunds, 1, Kerbey-st., Poplar, E.*	997

* Accepted.

CAMBRIDGE. — For two houses, Richmond-road, Huntingdon-road, for Mr. A. Giordano:—

Thoday & Son	£930
Williams	894
Kidman	892
Clayton	876
Kerridge & Shew	852
Saint	843
Coulson	785
Prime	760
Garrow	759
Alderton & Wheeler (Cambridge and London)	749

[All of Cambridge.]

CLAPHAM JUNCTION.—For new bank premises at Clapham Junction, for the London and South-Western Bank, Limited, exclusive of fitting. Messrs. Tolley & Son, architects, 66, Cannon-street. Quantities by Messrs. Parr & Sons, New Broad-street House:—

G. E. Bryan	£6,731
Gould & Brand	6,427
J. & C. Bowyer	6,342
W. Shepherd	6,200
W. Johnson	6,100
J. F. Chappell	6,049
C. Kynoch (accepted)	5,875

HAMMERSMITH.—For the erection of new board-room, offices, dispensary, &c, Fulham Palace-road, Hammersmith, for the Guardians of the Poor of the Fulham Union. Messrs. H. Saxon Snell & Son, architects, London:—

Oldrey & Co., Westbourne Park	£19,127
Mowlem & Co., Millbank	19,057
Ward Clarke, Pomeroy-street, S.E.	18,888
T. Bendon, Hammersmith	18,830
J. H. Mollett, 42, Imperial-buildings, E.C.	18,811
H. Knight, Morden	18,630
Wall Bros., Carlton-road, N.W.	18,625
J. T. Chappell, Pimlico	18,617
Leslie & Co., Kensington	18,579
W. J. Adcock, Ladywell, Dover	18,479
Longley & Co., Crawley	17,484
Ashfold & Co., West Kensington	17,432
Flew & Co., 5, West Kensington-terrace	17,350
Thos. Nye, Ealing, Middlesex*	17,100
A. Brickell, West Kensington	16,990
Rose & Co., Fulham	16,315

* Accepted.

DARENTH (Kent).—For laying gas-mains and supplying and fixing road-lamps in the roads of the New Blocks of the Asylum for Imbeciles, Darenth, near Dartford, Kent, for the Metropolitan Asylums Board. Messrs. A. & C. Harston, architects, 15, Leadenhall-street, E.C. Quantities not supplied :—

Coxall & Co.	£495 0 0
Sugg & Co.	418 17 6
Potter & Son	409 10 0
R. Crane	398 0 0
Christie	393 15 0
Summerscales & Son	390 0 0
T. Torode	390 0 0
Williams & Co.	378 10 0
F. Bird & Co.	365 0 0
Hayward Bros. & Eckstein	356 0 0
Benham & Son, Wigmore-street, W.*	351 0 0

* Accepted.

LONDON. — For finishing No. 43, Nevern-square, South Kensington, for Mr. E. Ward. Messrs. Morley & Letts, surveyors, 185, Earl's Court-road, S.W :—

Toten & Sons	220 0 0
T. W. Heath*	220 12 0

* Accepted, exclusive of stoves, over-mantels, and wall-hangings.

LONDON.—For sanitary works at 19, Nevern-square, S.W., under the direction of Messrs. Morley & Letts, surveyors, 185, Earl's Court-road, S.W. :—

Toten & Sons	110 0 0

LONDON —For further works to premises No. 21, Budge-row, E.C., for Messrs. James Wrigley & Son, Limited. Mr. Albert E. Pridmore, architect, 2, Broad-street-buildings, E.C. :—

T. Taylor (accepted)	£106 0 0

[No competition.]

LONDON.—For painting and decorating work, &c., at West Lodge, Barnsbury-square, N., for Mr. E. H. Bayldon. Mr. Albert E. Pridmore, architect, 2, Broad-street-buildings, E.C. :—

J. Crane (accepted)	£132 8 0

LONDON.—For alterations and additions to No. 88, Upper-street, Islington, for the Misses Edwards. Mr. Edmund J. Harrison, architect, 72, Chancery-lane, W. :—

H. Baylis, Highbury (accepted)	£334 0 0

LONDON.—For additions to No. 53, Devonshire-street, Islington, for Dr. F. H. Hume. Mr. Edmund J. Harrison, architect. 72, Chancery-lane, W.C. :—

W. Goodman	£183 0 0
Drew & Cadman	182 0 0
G. Huckett	167 10 0
J. H. Fernley, Upper Tollington Park, N. (accepted)	115 0 0

LONDON.—For repairing, painting, decorating, sanitary and other works, at 74, Grosvenor-street, W., for Dr. Thomas Buzzard. Mr. M. P. Manning, architect. Sanitary works under the superintendence of Prof. Corfield :—

McCormick & Sons, 34, Canonbury-road, Islington. N. (accepted)	£735 0 0

ORPINGTON (Kent).—For the erection of new stables and for various works. Mr. St. Pierre Harris, architect and surveyor, 1, Basinghall-street, E.C. :—

G. Johnson (too late)	£506 0 0
W. Owen	437 0 0
Somerford & Son	387 0 0
Knight*	369 0 0

* Accepted, subject to modification.

PECKHAM.—For bringing out shop, &c., at 118, Rye-lane, for Messrs. Airey & Pearson. Mr. John Farrer, architect, 20, Finsbury-pavement :—

Newton, Peckham	£578 0 0
Bate, Peckham	480 0 0
Treweeke, Peckham	463 10 0
Lobb & Cloer, Peckham	438 0 0
Smith & Son, Norwood	415 0 0
W. Smith, Camberwell	413 10 0
Money Marsland, Wandsworth*	412 0 0

* Accepted.

SOUTHWARK.—For alterations at the "Winchester Arms," Suffolk-street, Borough, for Mr. James Whiffen. Mr. E. J Eedle, architect :—

Walker & Sons (accepted)	£1,500 0 0

Gasfitter.—W. Winn (accepted).
Pewterer.—J. Davidson (accepted).

WANDSWORTH.—For erecting stables at the "Two Brewers," for Messrs. Young & Co. :—

Money Marsland (accepted)	£200 0 0

[No competition.]

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D. & Co. (sample received).—F. W. B.—W. N.—E. R.—J. H.—E. E. G.—J. W.—J. E. C. (we have not space for so long a letter, and we are satisfied that our general representation is correct. We have no interest in the matter, and you probably have).—P. S. W. (thanks; not required).—W. C. (the work is under the direction of an architect of ability, to our knowledge.)

All statements of facts, lists of tenders, &c., must be accompanied by the name and address of the sender, not necessarily for publication.

We are compelled to decline pointing out books and giving addresses.

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AN EDITION Printed on THIN PAPER, for FOREIGN CIRCULATION, is issued every week.

READING CASES, Now ready. { NINEPENCE EACH. By post (carefully packed), 1s.

W. H. Lascelles & Co.

121, BUNHILL ROW, LONDON, E.C.

Telephone No. 270.

HIGH-CLASS JOINERY.

LASCELLES' CONCRETE.

Architects' Designs are carried out with the greatest care.

CONSERVATORIES,
GREENHOUSES,
WOODEN BUILDINGS.

Bank, Office, & Shop Fittings.

CHURCH BENCHES & PULPITS.

ESTIMATES GIVEN ON APPLICATION.

BEST BATH STONE.

CORSHAM DOWN. | FARLEIGH DOWN.
BOX GROUND. | COMBE DOWN.
WESTWOOD GROUND. | STOKE GROUND.

THE BATH STONE FIRMS, Limited.
HEAD OFFICES: BATH.

DOULTING FREESTONE.

THE CHELYNCH STONE. The stone from these quarries is known as the "Weather Beds," and is of a very crystalline nature, and undoubtedly one of the most durable stones in England.

THE BRAMBLEDITCH STONE. Is of the same crystalline nature as the Chelynch Stone, but finer in texture, and more suitable for fine moulded work.

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London Agent—Mr. E. A. WILLIAMS,
16, Craven-street, Strand, W.C. [ADVT.

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Asphalte.—The Seyssel and Metallic Lava Asphalte Company (Mr. H. Glenn), Office, 42, Poultry, E.C.—The best and cheapest materials for damp courses, railway arches, warehouse floors, flat roofs, stables, cow-sheds, and milk-rooms, graneries, tun-rooms, and terraces. [ADVT.

Asphalte.
Seyssel, Patent Metallic Lava, and White Asphaltes.
M. STODART & CO.,
Office:
No. 90, Cannon-street, E.C. [ADVT.

SPRAGUE & CO.,
LITHOGRAPHERS AND PRINTERS,
Estate Plans and Particulars of Sale promptly executed.
22, Martin's-lane, Cannon-street, E.C. [ADVT.

Southwark Lift Gears.—Now made in fifty sizes, all complete and ready for delivery. Prices on application. All the parts of Lifts (except the cage or boxes) kept in stock. A large collection of Gears and other Hoisting Machinery now on show at the "Ironmongers' Exhibition," Agricultural Hall (special position left of centre).—J. STANNAH, 20, Southwark Bridge-road, London. [ADVT.

MICHELMORE & REAP,
Manufacturers of
CHARLES COLLINGE'S PATENT.
COLLINGE'S PATENT HINGES,
LEVER, SCREW, & BARREL BOLTS,
Self-Acting "FALL DOWN" GATE STOPS,
and IMPROVED GATE FITTINGS of every Description.
36A. BOROUGH ROAD,
PRICES REDUCED. LIST SENT ON APPLICATION. LONDON, S.E.

SHORT TIME CONTRACTS

Can be carried out easily by using our Lamps.

YOU CAN

WORK ALL NIGHT

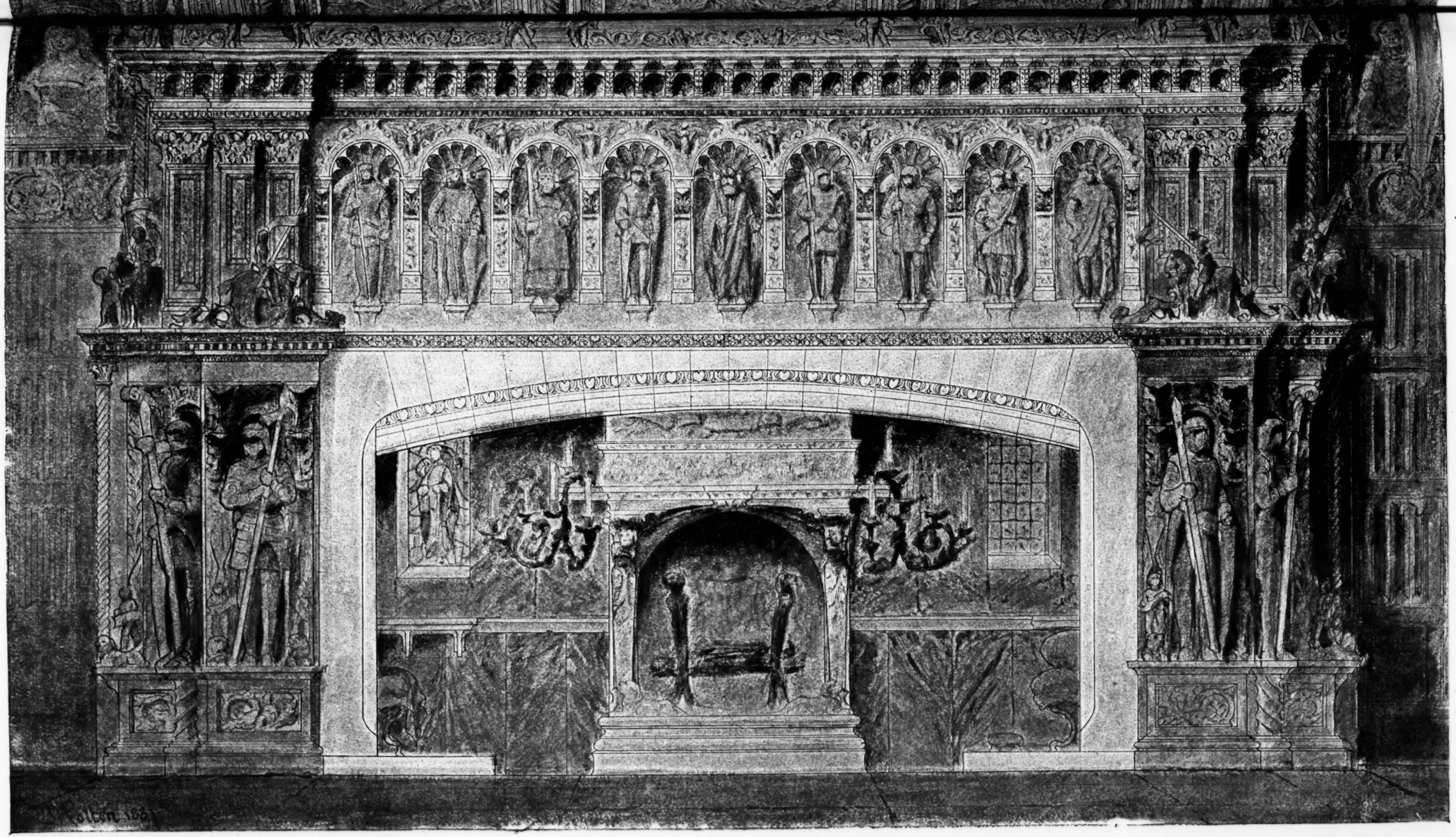
AT MUCH LESS COST THAN BY GAS. ✣ NO STEAM OR AIR-PIPES REQUIRED.

Entirely Self-Contained. Portable. Very Cheap.

F. BRABY & CO., 352 TO 362, EUSTON ROAD, LONDON, N.W.

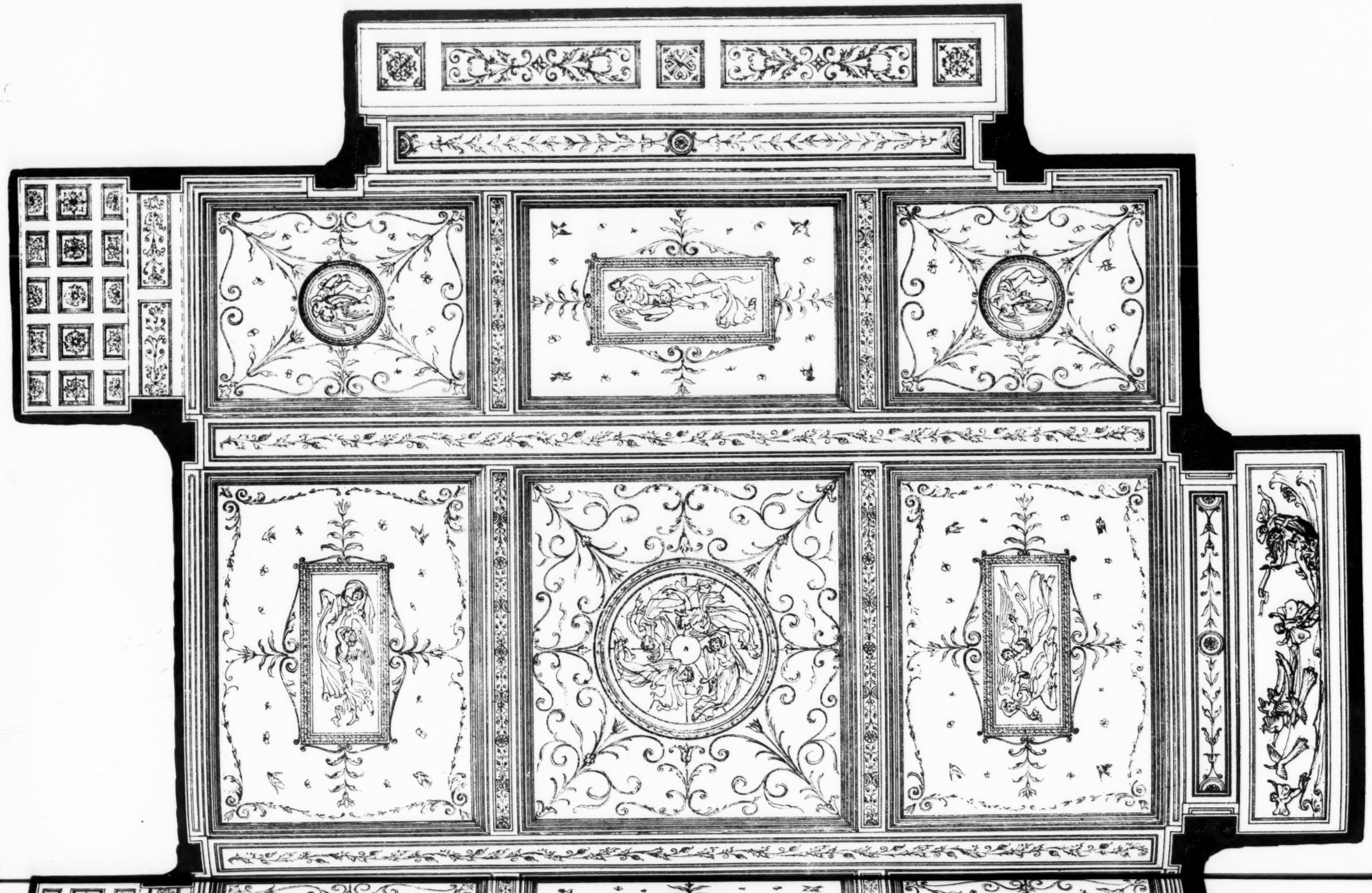
There are still a few districts in which we are not yet represented. Correspondence invited.

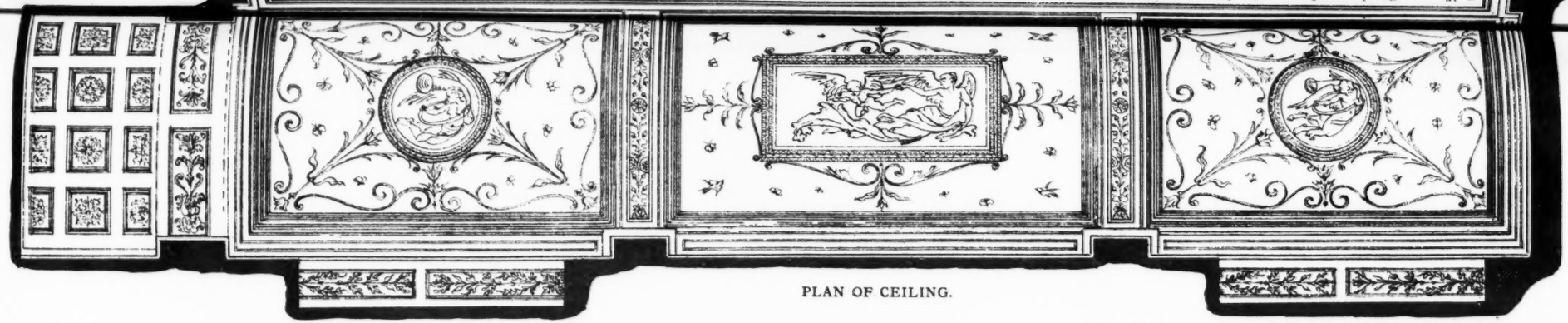
Saint George For Merry England



The Phototype Co., 303, Strand, London.

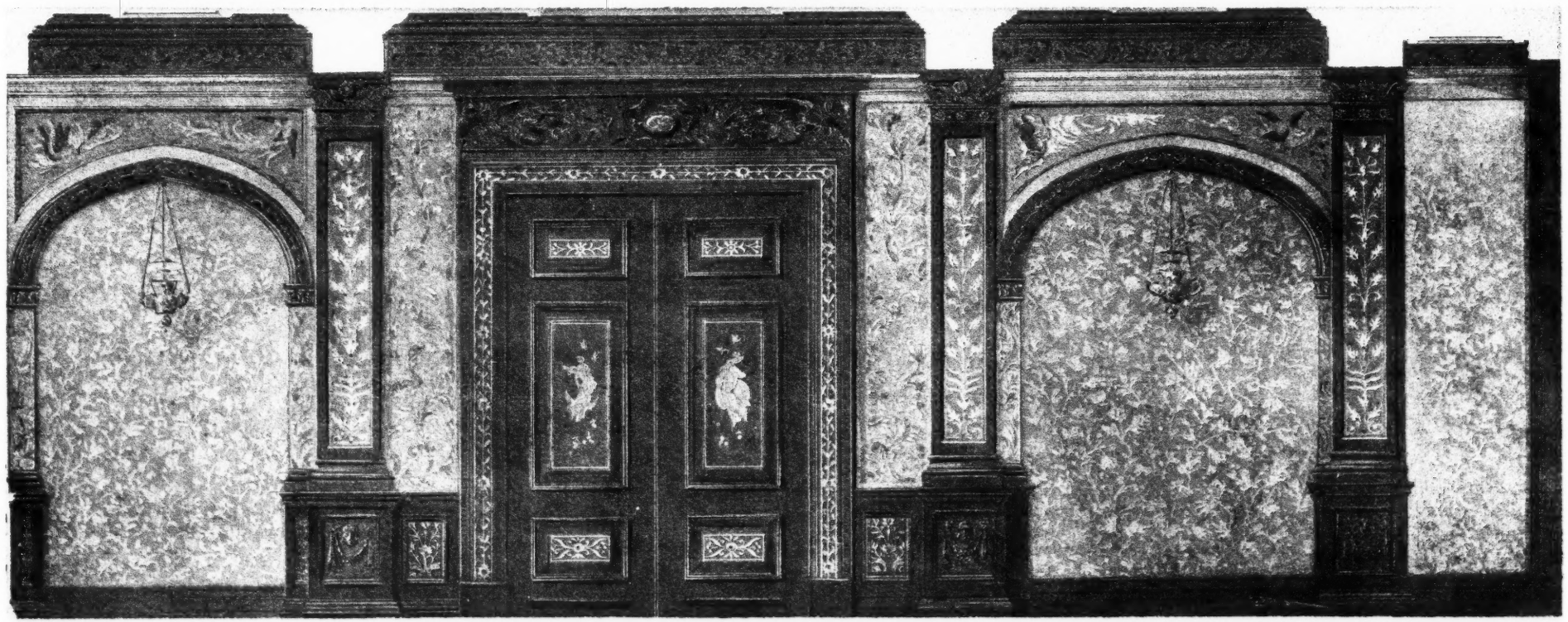
DESIGN FOR A CHIMNEY-PIECE. By Mr. T. HUNGERFORD POLLEN.





PLAN OF CEILING.

0 10 20 FEET



ELEVATION OF ONE WALL.

"INK-PHOTO," SPRAGUE & Co, 22, MARTINS LANE, CANNON ST, LONDON, E.C.

DECORATION FOR DRAWING ROOM.—Designed by Mr. Geo. Aitchison, A.R.A.; Figures in Panels by Mr. S. P. Cockerell.

DESIGN FOR A RAILWAY TERMIN

PHOTO-LITHO. SPRAGUE & Co 22, MARTINS LANE, CANNON ST, LONDON, E.C.

TERMINUS.—By Mr. W. H. Boney.

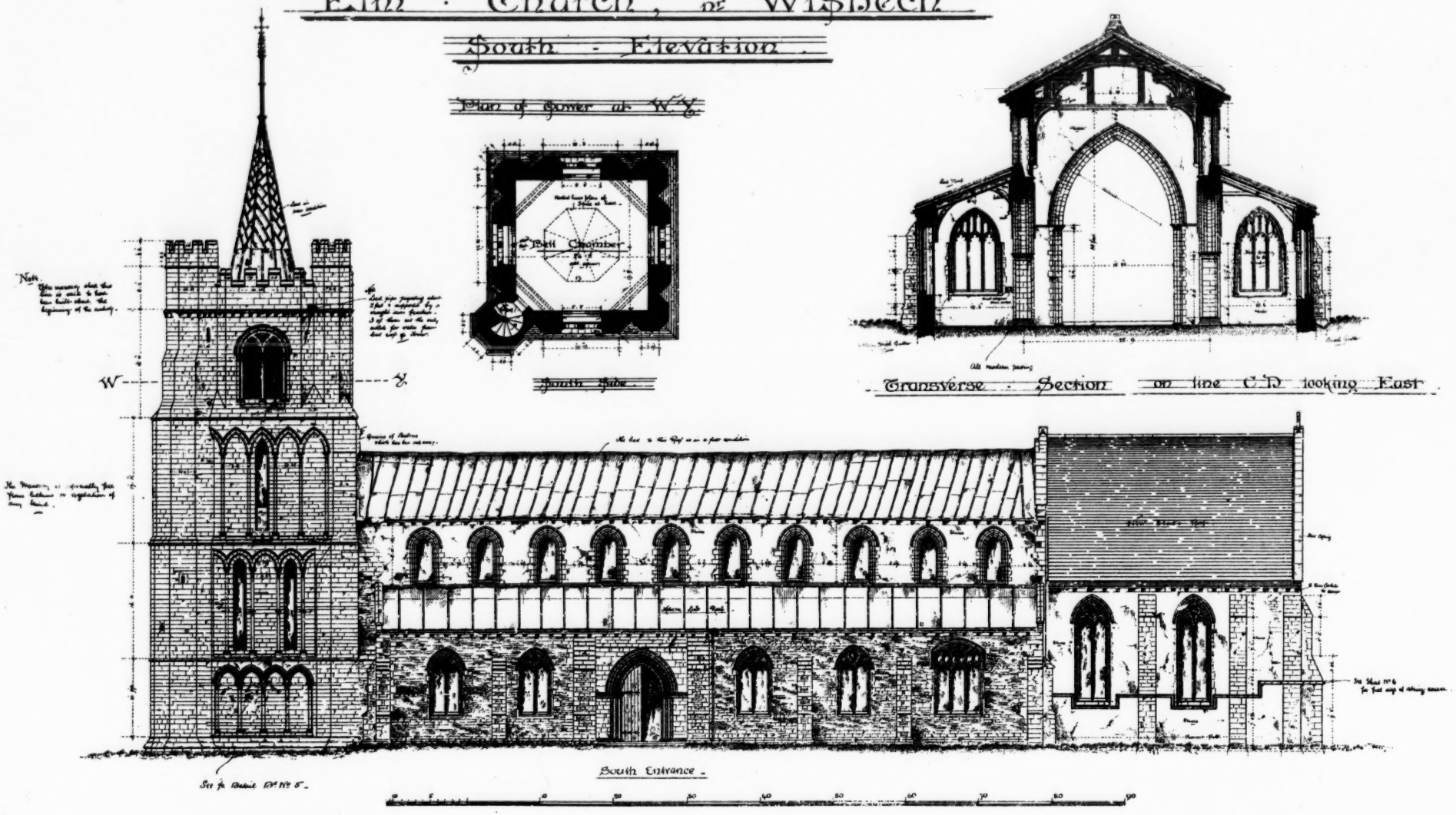
Elm · Church, nr Wisbech

South - Elevation.

Plan of Tower at W.Y.

South Side.

Transverse Section on line C.D looking East.

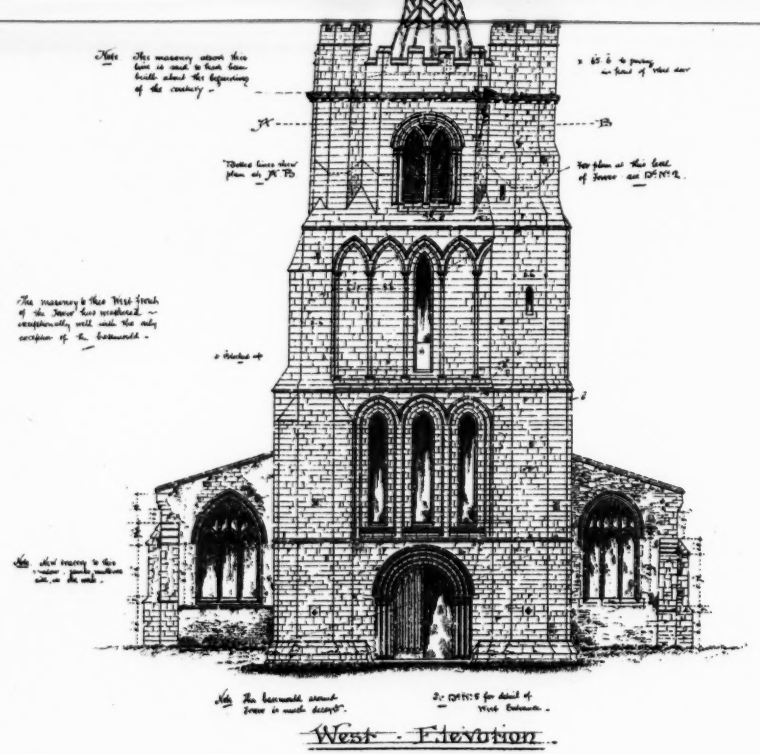


South Entrance.

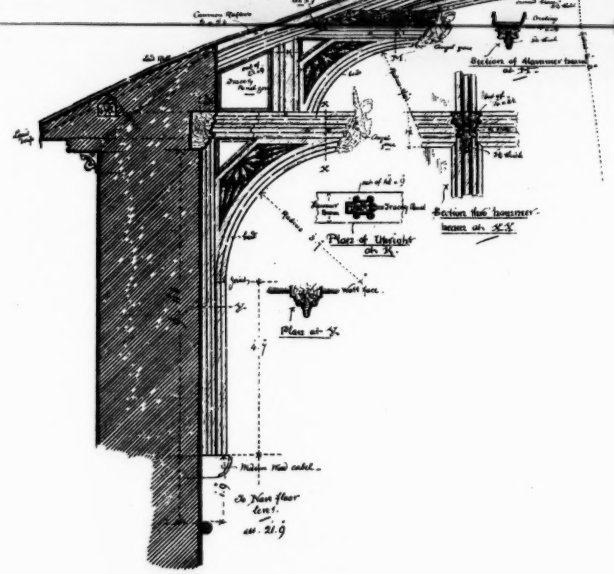
0 5 10 20 30 40 50 60 70 80 100

Detail of Nave and North Aisle Roofs.

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39



West · Elevation



Section thro' Transept looking East

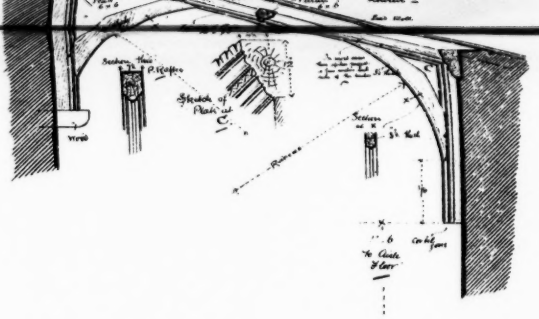
Plans of Uprights on X.

Plans at X.

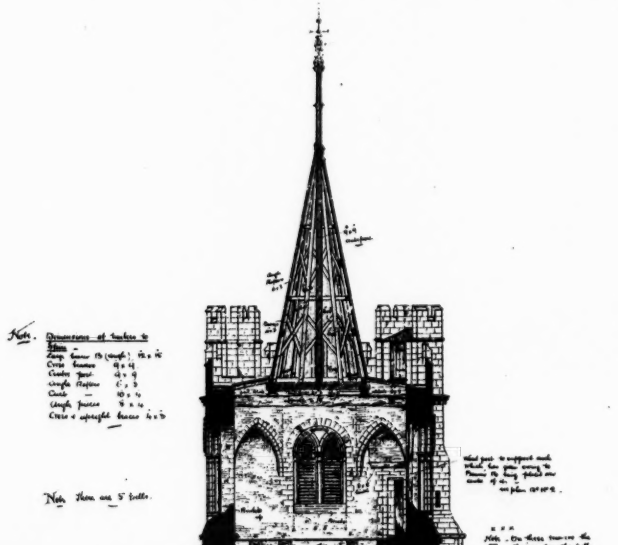
Section thro' Roof looking West on X Y

Works on Condition of Nave Roof.

The timbers to the trusses are generally in good condition being partly fir from decay but the framing together of many of them has given - most of the transom beams having risen considerably in many cases necessitating the use of tie straps which have not been used both cases. The existing angle open tracery pinnacle & other enrichment have nearly all gone - Only one angel is perfect - there are remains of 8 or 10 more -



Section on line A.B. looking South



Chancel

Tower

Scale of feet.

PHOTO-LITHO, SPRAGUE & Co 22, MARTINS LANE, CANNON ST, LONDON, E.C

DRAWN BY Mr. S. K. GREENSLADE.

Awarded the Neale Prize, Architectural Association, 1888.